Earth Systems
Environmental Engineering

November 14, 2018

Mr. Phil Cole
New Jersey Department of Environmental Protection
Bureau of Case Management
Mail Code 401-05F
PO Box 420
Trenton, New Jersey 08625-0420

Re: Soil Remedial Action Design
AOC 3: No. 1 Landfarm
Hess Corporation Former Port Reading Complex (HC-PR)
835 West Avenue
Port Reading, Middlesex County, New Jersey
Program Interest No. 006148
NJDEP ISRA Case No. E20130449
EPA ID No. NJD045445483

Dear Phil:

Attached please find the Soil Remedial Action Design (3 hardcopies and 1 disc) for AOC 3: No. 1 Landfarm for the above-referenced site. Please feel free to contact me at (732) 739-6444 if you have any questions or require additional information.

Sincerely,
EARTH SYSTEMS

John S. Virgie LSRP, PG
Senior Client Manager

cc:
Mr. Andy Park - USEPA
Mr. John Schenkewitz, Manager, Remediation - Hess Corporation
Mr. Rick Ofsanko – Earth Systems

SOIL REMEDIAL ACTION DESIGN

Former Port Reading Refining Facility
AOC-3: No. 1 Landfarm
750 Cliff Road
Port Reading, Middlesex County, New Jersey
ISRA Case # E20130449
NJDEP PI # 006148
EPA ID # NJD045445483

November 2018

Prepared For:

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

PO Box 420

401 East State Street

Trenton, New Jersey 08625

And:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

290 Broadway

New York, New York 10007

On Behalf Of:

HESS Corporation
Trenton-Mercer Airport
601 Jack Stephan Way
West Trenton, New Jersey 08628

Prepared By:

Earth Systems
Environmental Engineering
1625 Highway 71
Belmar, New Jersey 07719

And:

Key Environmental, Inc.
200 Third Avenue
Carnegie, Pennsylvania 15106

PROFESSIONAL ENGINEER SIGNATURE PAGE

I certify that I have provided regular and effective supervision to those individuals performing services that directly and materially affect the quality and competence of the engineering work rendered in the document titled, "Soil Remedial Action Design, AOC-3: No. 1 Landfarm, Hess Corporation, Former Port Reading Refining Facility, Port Reading, Middlesex County, New Jersey, NJDEP PI#006148, ISRA Case No. E20130449, EPA ID No. NJD045445483" dated November 13, 2018.

Certificate of Authorization:

Certificate of Authorization Number 24GA27961400
Expiration Date: August 31, 2020
Person in Responsible Charge: Peter W. Sawchuck
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November 13, 2018
Date

Alan E. Briggs, P.E.
State of New Jersey
Professional Engineer Number: 24GE03878500
Expiration Date: April 30, 2020

STATE OF NEW JERSEY
ALAN E. BRIGGS
No. GE38785
LICENSED
PROFESSIONAL ENGINEER

SIGNATURE 11/13/18 DATE

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ACRONYMS / ABBREVIATIONS

Advent	Advent Group, Inc.
amsl	above mean sea level
AOC	Area of Concern
API	American Petroleum Institute
Aware	Aware Corporation
CEA	Classification Exception Area
CFR	Code of Federal Regulations
cm/sec	centimeters per second
DST	discharges to surface water
DSW	Discharge to Surface Water
Facility	Former Port Reading Refining Facility
FCCU	Fluidized Catalytic Cracking Unit
GCL	geosynthetic clay liner
GP	General Permit
Hess	Hess Corporation
HSWA	Hazardous and Solid Waste Amendments
ISRA	Industrial Site Recycling Act
KEY	Key Environmental Inc.
LF1	No. 1 Landfarm
LLDPE	liner low density polyethylene
NAD	North American Datum
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJPDES	New Jersey Pollutant Discharge Elimination System
oz/sy	ounces per square yard
RAD	Remedial Action Design
RAO	Remedial Action Objective
RAW/PCMP	Remedial Action Workplan/Post Construction Monitoring Plan
RCRA	Resource Conservation and Recovery Act
SPPP	Stormwater Pollution Prevention Plan
SVOCs	semi-volatile organic compounds
TEL	tetraethyl lead
TWA	Treatment Works Approval
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

1.1 BACKGROUND

This Remedial Action Design (RAD) report was prepared by Key Environmental Inc., (KEY) for the Hess Corporation (Hess), on behalf of Earth Systems, Inc., in association with Area of Concern No. 3 (AOC-3): No. 1 Landfarm (LF1), located at the Former Port Reading Refining Facility (Facility) in Port Reading, Middlesex County, New Jersey. LF1 is referenced under New Jersey Department of Environmental Protection (NJDEP) Program Interest Number 006148, Industrial Site Recycling Act (ISRA) Case Number E20130449, and the United States Environmental Protection Agency (USEPA) ID No. NJD045445483. This report has been prepared to provide technical information required to meet the design requirements for closure of LF1 as identified in the Remedial Action Workplan/Post Construction Monitoring Plan (RAW/PCMP) prepared by Earth System and submitted to NJDEP Bureau of Case Management on September 13, 2016. The selected remedy includes the construction of a low permeability cap over LF1, to meet the closure performance standards of the Resource Conservation and Recovery Act (RCRA) closure and post-closure requirements, as specified in 40 Code of Federal Regulations (CFR) 265.

1.2 SITE DESCRIPTION

The Hess Facility is an approximate 210-acre irregularly shaped parcel, situated in an industrially developed waterfront area. A Site Location map for the Facility is presented on Design Drawing LF1-G-001. The Facility formerly processed low sulfur gas oils and residuals as feed to a Fluidized Catalytic Cracking Unit (FCCU) that converted gas oil into gasoline, fuel oil, and other hydrocarbon products (e.g. methane, ethane and liquid petroleum gas). Site operations were initiated in 1958 with a Crude Topping Unit and underwent various expansions between 1958 and 1970. In 1974, refining operations were suspended and the Facility operated as a bulk storage and distribution terminal until 1985. In April 1985, following a retrofit, the Facility resumed refining operations. Later the refinery was closed and demolition of the refinery was completed in 2015. Currently the Site is operated only as a bulk storage and distribution terminal. The refinery utilized on-site land treatment (i.e., landfarming) to effectively treat and dispose of waste.

1.3 LANDFARM HISTORY

LF1 began operation in 1985, and was part of the waste management system for the Hess tank farm operations, receiving refinery / terminal waste products from the on-site American Petroleum Institute (API) Separator (hazardous waste code K051), heat exchanger bundle cleaning, recoverable oil tank bottoms, leaded tank bottoms (hazardous waste code K052) and tetraethyl lead (TEL) bottoms. When operation of LF1 began, over 255 cubic yards of impacted soils were removed from the Hess Facility South Landfarm and were applied to LF1 as proposed in the NJDEP approved South Landfarm Closure Plan, April 1985 (Earth Systems, 2016b).

LF1 is a RCRA-permitted land treatment system encompassing approximately 2 acres (87,120 square feet) (Advent, 1986). The LF1 was constructed in 1985 with dredged sediments from the Arthur Kill. Design Drawing LF1-C-101 "Existing Conditions", depicts the location of the LF1 and the existing monitoring wells. LF1 has a top surface elevation ranging from approximately 12 to 16 feet above mean sea level (amsl), and is completely surrounded by dike walls, which prevent surface water from running onto the landfarm. Stormwater outside the boundaries of the landfarm either percolates into the ground or sheet flows to the existing northern drainage ditch, an unnamed tributary to the Arthur Kill.

Four permitted monitoring wells, designated as L1-1 through L1-4, were installed along the eastern, northern and western perimeter of the LF1 in October 1985. These wells, along with two background wells (BG-2 and BG-3) are sampled on a quarterly basis in accordance with the New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Groundwater permit. Quarterly groundwater monitoring will continue at LF1 until closure is completed. The results of the quarterly sampling are reported to the NJDEP on a semiannual basis, with the latest report dated July 25, 2016.

LF1 is currently in Interim Status under oversight of the NJDEP Site Remediation Program, through a voluntary cleanup agreement between Hess Corporation and NJDEP and a Hazardous and Solid Waste Amendments (HSWA) permit issued by USEPA under the RCRA. USEPA and NJDEP work together in overseeing the site corrective action/remediation. USEPA is the lead for RCRA corrective action and the NJDEP is the lead for the post-closure permitting of the landfarm. LF1will be closed pursuant to the requirements for RCRA landfills specified in 40 CFR 265.310 (Landfills) (Earth Systems, 2016a). The materials will be managed as Hazardous Materials, meeting the RCRA treatment requirements and land disposal restrictions of 40 CFR 268 – Land Ban Restrictions.

1.4 DESCRIPTION OF AOC-3

LF1 was constructed and operated under a RCRA Part B Permit for the treatment of hazardous waste in 1985. Following construction, a Treatment Demonstration was conducted to assess the validity of land treatment as a method of disposal for the particular wastes and site under consideration. A Report of the findings was prepared and submitted by Advent in 1987 (Advent, 1987).

Based on a review of historical design documents provided, LF1 consists of two bays, separated by a dike. Each bay has an approximate five foot thick Treatment Zone consisting of a three feet of treatment zone soil, one foot of highly permeable sand, and one foot of compacted low permeability clay with a maximum hydraulic conductivity of 1×10^{-7} cm/sec. A three to four foot wide perimeter dike encircles the two bays and is constructed at a 2H:1V side slope. The compacted low permeability clay layer was reportedly located so that the bottom of the treatment zone was a minimum of three feet above the water table and is sloped at one percent. The clay layer covers the bottom and interior sideslopes of the perimeter dike and Bay 1/Bay 2 interim dike.

A highly permeable sand layer was installed above the clay layer and leachate collection piping was installed adjacent to the perimeter dike on the north and east sides of Bay 1 and along the east side of Bay 2. The leachate collection piping consists of six-inch diameter perforated PVC or vitrified clay pipe surrounded by crushed rock and enveloped in a geotextile fabric. The perforated pipe from the underdrain system conveys liquids to the landfarm drainage sump via solid wall PVC pipe. The LFI surface materials consist of coarse aggregate or vegetation. Previously, wastewater was applied to LF1 for treatment.

1.5 LEACHATE COLLECTION AND TREATMENT SYSTEM

Historically, leachate from the LF1 was directed to an on-site treatment facility which was closed in 2015. In anticipation of this, Hess applied for and obtained a NJPDES Master General Permit (No. NJ0102709) and NJPDES Discharge to Surface Water (DSW) B4B Permit (No. NJG0225720) with a Treatment Works Approval (TWA) (No. 14-0306) for the treatment and discharge of leachate water to the adjacent north drainage ditch. Installation of the leachate treatment system was completed and discharge to the north drainage ditch began in October 2014. The LF1 leachate treatment system was upgraded in September 2016 under amended NJDEP TWA No. 14-0306a.

The treatment system operates intermittently, based on the leachate level at the lift station transfer pump/and or the leachate level sensed in the leachate sump. It is anticipated that the LF1 leachate collection and treatment system will be decommissioned following the installation of the low permeability cap on LF1, and subsequent reduction/elimination of leachate production and collection.

1.6 REMEDIAL ACTION OBJECTIVE

The RAW/PCMP indicated that soils at the Site are impacted with semi-volatile organic compounds (SVOCs) and metals (i.e., lead), with discrete concentrations slightly above the applicable soil remediation standards, while groundwater is impacted only with metals. The Remedial Action Objective (RAO) for soils is to address the direct contact pathway for potential human health and ecological receptors. The groundwater ingestion pathway will be addressed independently of this document via establishment of a Classification Exception Area (CEA).

1.7 REMEDY DESCRIPTION

As discussed above, a low permeability cap is proposed as the remedial action to address the direct contact pathway for potential human health and ecological receptors. The cap system will be comprised of multiple layers of manufactured and earthen materials, designed to both shed direct runoff from stormwater as well as to drain percolation that reaches the surface of the low permeability components of the system. The components of the cap system are described in greater detail in Section 2.2 of this report.

1.8 PERMIT REQUIREMENTS

Implementation of the soil remediation may require Federal, State and local agency authorizations, permits and/or approvals. The specific type of Federal, State or local authorizations required and associated permit conditions(s) are dictated by the nature of the activity and its location.

The following is a summary of the permits that are currently anticipated for this project:

- Freehold Conservation District Certification of a Soil Erosion and Sediment Control Plan including a Stormwater Pollution Prevention Plan (SPPP); and,
- Construction Activity Stormwater General Permit (GP) 5G3 in accordance with New Jersey's Stormwater Management Rules (N. J. A. C. 7:8) are implemented by the NJDEP. The general permit controls stormwater discharges to surface water (DST) from certain construction activities, including clearing, grading and excavating. The GP may be applicable for the closure of LF1 as the regulation states that a landfill may be deemed eligible when a written determination is made by the NJDEP that the permit requirements are sufficient to control the construction activities. The Department has the ability to authorize construction activity when a determination is made that the general permit requirements will protect the quality of the waters of the State. If NJDEP determines that the GP is not sufficient, then an individual NJPDES Industrial Stormwater Permit will be required.

2.0 DESIGN

The RAW/PCMP identified as part of the overall site remedy the construction of a low permeability cap system. The cap remedial action will address the RAO to eliminate the direct contact pathway for potential human health and ecological receptors. The cap will be constructed over the limits of LF1. The limits were generally depicted in the RAW/PCMP, but for the purposes of this design they were subsequently adjusted slightly to coincide with the outside of the perimeter dike as determined by field survey, as shown on Design Drawing LF1-C-101.

2.1 PRE-DESIGN ACTIVITIES

A geotechnical investigation and field survey of existing conditions were performed to support the remedial design activities. A summary of the related activities and findings is presented below.

2.1.1 Geotechnical Investigation

Soil borings were performed in June 2018 and in-situ and geotechnical laboratory testing was conducted to obtain information regarding the lithology, consistency, geotechnical index properties, shear strength, and compressibility of materials located within and outside of the perimeter (i.e. exterior) dikes of LF1. Hollow-stem auger borings KB18-8, KB18-9, KB18-10 and KB18-11 and their respective offset borings were located outside of the perimeter dike of LF1.

Hand-auger borings KHA18-6 and KHA18-7 were advanced into the inboard slope of the perimeter dike of LF1 and hand auger boring KHA18-2 was located near the center of Bay 1 of LF1. Hollow-stem and hand auger boring locations are shown on Figure 1 of Appendix A. The geotechnical investigation report, including a detailed description of the geotechnical field investigation and geotechnical laboratory testing program, daily field activity logs, photographs, boring logs, a summary of geotechnical laboratory test results, and geotechnical laboratory data, is also provided in Appendix A.

2.1.2 Field Survey

Ground surface topography, physical features, and the geotechnical boring locations were field-surveyed by a surveyor licensed in the state of New Jersey (DPK Consulting Land Surveyors of Piscataway, New Jersey). Survey activities were conducted during August 2018. The survey references the New Jersey State Plane Coordinate System, North American Datum of 1983 (NAD83) and North American Vertical Datum of 1988 (NAVD88). The surveyor's map indicating ground surface topography and exposed surface physical features and information obtained from the original LF1 design (Aware, 1985a and 1985b) were used to prepare the existing site conditions plan provided as Design Drawing LF1-C-101. The grid coordinates and ground surface elevation for each geotechnical boring are provided on their respective boring log.

2.2 BASIS OF DESIGN

The design of the LF1 cap system is consistent with the USEPA-recommended final cover design for RCRA Subtitle C facilities as described in EPA 625/4-91/025, "Design and Construction of RCRA/CERCLA Final Covers" and updated in EPA 540-R-04-007, "(Draft) Technical Guidance for RCRA/CERCLA Final Covers". The cap system components, with nomenclature used in the USEPA guidance underlined, are as follows:

- Bedding/Foundation Layer – select landfarm and perimeter dike materials, or imported common fill as necessary, regraded and compacted with a (pre-settlement) surface slope of five percent, sloped downward toward the landfarm perimeter;
- Gas Collection Layer – geonet with lower geotextile;
- Hydraulic Barrier – geosynthetic clay liner (GCL);
- Hydraulic Barrier – 40 mil liner low density polyethylene (LLDPE) geomembrane;
- Drainage Layer – geonet, with single- or double-sided geotextile;
- Protection Layer – 18-inch thick layer of common fill;
- Non-woven Geotextile; and,
- Surface Layer – 6-inch thick layer of coarse aggregate with a (pre-settlement) surface slope of five percent, sloped downward toward the landfarm perimeter.

2.3 FINAL DESIGN

Detailed design calculations were prepared and are included as Appendix B. Design Drawings were prepared to fully depict the proposed installation, and are included as Appendix C. Technical Specifications were also prepared to identify the materials and methods of construction required to complete the installation; the Technical Specifications are included as Appendix D.

The proposed grading configurations shown on Design Drawings LF1-C-103 and LF1-C-104 were designed to: reduce the height of the existing perimeter dike to the extent practical; minimize the quantity of off-site common fill material required to achieve the subgrade surface and minimum slope; minimize the effect of settlement due to consolidation of underlying soil; and, provide post-consolidation grades to promote stormwater runoff.

Additional details of the cap system design are provided in the Design Drawings, in addition to other construction aspects of the work, such as erosion and sediment control. Design calculations were completed for the consolidation settlement of underlying soils, differential settlement of the final cap, veneer stability analyses, geosynthetic materials selection, and material quantity calculations. Design calculations are provided in Appendix B. A more detailed description of the proposed cap materials and associated design features for the LF1 cap is provided in subsequent sections.

2.3.1 Subgrade Preparation

The LFI will be cleared and grubbed as necessary, and the Bedding/Foundation Layer material will be placed to the grades shown on the subgrade grading plan (Design Drawing LF1-C-103). Existing dike and/or landfarm materials will be re-used to the maximum extent practical, and off-site borrow material will be obtained as necessary to achieve the subgrade elevations. In areas where excavation of existing dike and/or landfarm materials is required to achieve design grades the resultant surface will be proof-rolled and inspected for the presence of sharp objects or deleterious materials. If sharp objects or deleterious materials are not observed the surface will be deemed acceptable for overlying cap system placement; if the surface is unacceptable it will be excavated to a depth of an additional 12 inches and replaced with suitable Bedding/Foundation Layer material.

The grades are based on providing a final cap that fully covers the limits of the existing perimeter dike. In general, the surface of the proposed subgrade will “tie in” into the existing perimeter dikes at approximately elevation 11 feet (NAVD88) on the western side of LF1, and gradually rising to approximately elevation 15 feet (NAVD88) on the eastern side of LF1. The elevations for the “tie-ins” were determined by considering the location of the existing leachate collection system, with an effort to also minimize the quantity of fill material needed to complete the cap (and thereby reduce potential consolidation settlement). The pre-settlement design slope of the subgrade and final cap surface is five percent. Based on the consolidation settlement calculations provided in Appendix B it is anticipated that settlement may result in a decrease in surface slope of less than

one percent. Therefore the proposed subgrade and cap slopes will provide for a final grade well in excess of three percent after anticipated consolidation settlement has occurred, which is considered to be acceptable for cap drainage considerations.

2.3.2 Cap Components

The cap will be installed to the limits shown on Design Drawing LF1-C-104. Details of the cap installation are provided on Design Drawing LF1-C-502. The components of the cap system are described below:

- The Bedding/Foundation Layer will be placed in compacted lifts and will consist of landfarm material with a specified maximum particle size. The subgrade will be proof-rolled prior to receiving subsequent layers. If imported fill is required the material will meet the same specification.

- A Geocomposite Gas Collection Layer will be placed over top of the Bedding/Foundation Layer to allow for the evacuation of gas build-up, if any. The passive gas management system will be monitored by periodically measuring combustible gas concentrations from the passive gas vents using a direct reading field instrument. The anticipated threshold is 500 parts per million (ppm) above background, consistent with 40 CFR 264.1054. The Geocomposite Gas Collection Layer is a passive system that will collect and convey gas to vertical riser outlets and vent to the atmosphere. The Geocomposite Gas Collection Layer will consist of geonet with a nonwoven needle-punched geotextile on the bottom side to prevent clogging.

- A Hydraulic Barrier consisting of a geosynthetic clay liner (GCL) will be provided to limit the percolation of water through the cap system and promote drainage in the overlying layers. This lower hydraulic barrier layer will be comprised of a reinforced GCL consisting of a layer of sodium bentonite, with a permeability of roughly 5×10^{-9} centimeters per second (cm/sec), between two nonwoven needle-punched geotextiles, stitch-bonded through the bentonite.

- A Hydraulic Barrier consisting of 40 mil LLDPE geomembrane will be installed on top of the GCL. The primary function of the geomembrane is to provide an additional hydraulic barrier layer above the landfarm materials, to further limit infiltration of precipitation into the LF1.

- The Geocomposite Drainage Layer will convey water that infiltrates through the cover soil to the perimeter limits of the AOC and thereby will reduce saturation of the cover soil layer and minimize the head on the geomembrane. The Geocomposite Drainage Layer will consist of geonet with nonwoven needle-punched geotextile on one or both sides, to prevent clogging.

- The 18-inch Protection Layer functions to protect underlying layers from freeze/thaw cycles, wet/dry cycles, and intrusions such as burrowing animals or plant roots. It also reduces water infiltration into underlying cap system layers. It will consist of common fill from an off-site borrow source.

- A non-woven geotextile with a weight of 6 ounces per square yard (oz/sy) and will function as a Separation Layer between the Protection Layer and the coarse aggregate Surface Layer.

The Surface Layer functions to stabilize the surface, resist erosion by water and wind, provide a biotic barrier to burrowing animals, with a readily maintainable surface. A 6-inch layer of coarse aggregate will serve as the surface layer. The coarse aggregate material will be an New Jersey Department of Transportation (NJDOT) No. 1 coarse aggregate (having a maximum particle size of 3-1/2 inches) at the perimeter terminus of the cap and NJDOT No. 2 or 3 coarse aggregate (having a maximum particle size of 2.5 inches) on the top plateau surface. The surface layer will be completed to the grades shown on Design Drawing LF1-C-104.

2.3.3 Stormwater and Erosion

The existing topography surrounding LF1 generally slopes away from the limits of the AOC. Consideration was given to the potential impacts from the increased runoff from the site once the low permeability cap has been installed on LF1. Final grades for the cap were designed to have a post-settlement slope greater than three percent to promote stormwater runoff. As shown on Design Drawing LF1-C-104, stormwater runoff will drain to the outside edge of the cap in all directions as sheet flow, and will discharge from the cap system to the surrounding ground and ultimately to the northern drainage ditch. The subcatchment drainage areas and slope lengths of the plateau portion of the cap system sloped at 5 percent range from 0.34- to 0.93-acres and 152 to 230 feet, respectively. The average annual soil loss for the plateau area is 0.16 tons/acre/year based on a conservative analysis using the Universal Soil Loss Equation, which is less than USEPA's 2 tons/acre/year criteria. The average annual soil loss for the 3H:1V cap sideslope area is .8 tons/acre/year based on a conservative analysis using the Universal Soil Loss Equation which is less than USEPA's 2 tons/acre/year criteria. The maximum slope for the 3H:1V sideslope is approximately 21 feet in length and is therefore insignificant. The Universal Soil Loss calculations are provided in Appendix B. In the eastern portion of the cap system the grading configuration could result in the development of concentrated flow in a very limited area. However, given the very small contributory drainage area and coarse aggregate surface treatment it is judged that the flow rates will be sufficiently low to preclude the need for a collection/diversion channel.

2.3.4 Existing Leachate Treatment System

The integrity of the existing leachate treatment system will be maintained. It is anticipated that, following the installation of the cap system, the quantity of leachate produced at LF1 will be greatly reduced. Following the construction of the cap system and attendant reductions in leachate

generation, an evaluation will be conducted to determine if the reduction of leachate will allow for operation of the leachate collection system to be discontinued.

3.0 POST-CONSTRUCTION OPERATIONS AND MAINTENANCE

Post-closure operations and maintenance activities will meet the requirements contained in 40 CFR 265.117 through 40 CFR 265.120. In accordance with the RAW/PCMP these activities will:

- Maintain the integrity and effectiveness of the final cap, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events;
- Maintain and monitor the leak detection system in accordance with 40 CFR 264.301(c)(3)(iv) and (4) of this chapter and 40 CFR 265.304(b), and comply with all other applicable leak detection system requirements of this part;
- Maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of subpart F of this part;
- Prevent run-on and run-off from eroding or otherwise damaging the final cap; and,
- Protect and maintain survey benchmarks used in complying with 40 CFR 265.309.

4.0 PROJECT SCHEDULE

An anticipated project schedule is provided as Appendix E. The schedule identifies important milestones which must be achieved to advance the project from design to construction, and ultimately through final construction reporting and regulatory approval. Task durations were estimated based upon experience with other similar project and may vary based on regulatory review duration, weather conditions during construction, etc.

5.0 CONSTRUCTION COST ESTIMATE

A construction cost estimate is provided as Appendix F. The cost estimate includes component costs on a line item basis, including line item descriptions, quantities, unit prices, and subtotal line item costs.

6.0 REFERENCES

Advent Group, Inc. (Advent), 1986. Work Plan, Land Treatment Demonstration Project for the RCRA Part B Permit Application. Prepared for Amerada Hess (Port Reading) Corporation, Port Reading, New Jersey. March.

Advent, 1987. Land Treatment Demonstration for Amerada Hess (Port Reading) Corporation. Prepared for Amerada Hess (Port Reading) Corporation, Port Reading, New Jersey. November 30.

Aware Corporation (Aware), 1985a. Drawing set titled "No. 1 Landfarm, Amerada Hess Corporation, Port Reading Refinery (Job No. 6217)." Prepared for Amerada Hess Corporation, Port Reading Refinery. January.

Aware, 1985b. No. 1 Landfarm Technical Specifications (Job No. 6217). Prepared for Amerada Hess Corporation, Port Reading Refinery, Port Reading, New Jersey.

Earth Systems Environmental Engineering (Earth Systems), 2016a. Remedial Action Workplan/Post-Closure Monitoring Plan, AOC-3: Landfarm No. 1, 750 Cliff Road, Port Reading, Middlesex County, New Jersey, NJDEP PI# 006148, ISRA Case No. E20130449, EPA ID No. NJD045445483. Prepared for Hess Corporation, West Trenton NJ. September 13.

Earth Systems, 2016b. Remedial Action Workplan/Post-Closure Monitoring Plan, AOC-2: South Landfarm, Hess Corporation – Former Port Reading Complex (HC-PR), 750 Cliff Road, Port Reading, Middlesex County, New Jersey, NJDEP PI# 006148, ISRA Case No. E20130449, EPA ID No. NJD045445483. Prepared for Hess Corporation, West Trenton, New Jersey. September 23.

APPENDIX A

GEOTECHNICAL INVESTIGATION REPORT

GEOTECHNICAL INVESTIGATION REPORT
SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM

HESS CORPORATION
FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

Prepared for:

Earth Systems, Inc.
Belmar, New Jersey

Prepared by:

Key Environmental, Inc.
200 Third Avenue
Carnegie, Pennsylvania 15106

September 30, 2018

KEY ENVIRONMENTAL INCORPORATED

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1.0 INTRODUCTION

Key Environmental, Inc. (KEY) has prepared this Geotechnical Investigation Report in accordance with the Geotechnical Investigation Work Plan for No. 1 Landfarm (LF1) under subtask 1.01 of KEY's proposal to Earth Systems Environmental Engineering (Earth Systems) dated January 16, 2018.

The objective of the geotechnical investigation and subsequent geotechnical laboratory testing was to obtain information regarding the lithology, consistency, geotechnical index properties, shear strength, and compressibility of materials located within and along the perimeter (i.e., exterior) operational (interior) dikes of LF1. The information obtained during the geotechnical investigation and laboratory testing program will be used to support preparation of the Soil Remedial Action Design (RAD) for LF1.

2.0 GEOTECHNICAL INVESTIGATION

The geotechnical field investigation activities were completed from June 4, 2018 through June 14, 2018, with oversight provided by a KEY field geologist. Drilling was performed by Uni-Tech Drilling Company, Inc. (Uni-Tech) of Bridgewater, New Jersey under subcontract to Earth Systems. Earth Systems provided instruction and direction to Uni-Tech pertaining to procedures for access, utility clearance and locating, equipment and personnel decontamination, drilling equipment decontamination procedures within and between borings, restoration, investigation derived waste (IDW) management, and post-installation survey.

Health and Safety

KEY's field activities were conducted in accordance with Earth Systems' Site-specific Health and Safety Plan (HASP) (Earth Systems, 2018). All personnel had current HAZWOPER training, participated in a 1-hour kick-off health and safety meeting, and attended daily tailgate safety meetings. Uni-Tech provided personal protective equipment (PPE) for their workers, and disposable PPE for the KEY geologist and Site visitors. PPE requirements are identified in Earth Systems' HASP.

Utility Location and Clearance

Prior to the installation of the geotechnical borings, underground utilities were surveyed and marked out by an underground utilities locating subcontractor coordinated by Earth Systems. Ground penetrating radar and an inductive utility line locator were used to detect underground utilities around LF1 and the leachate treatment system.

The initial 6 feet of hollow-stem auger borings were installed by Uni-Tech using "soft dig" techniques (i.e., air-knife and hand auger) in accordance with Hess Corporate EHS & SR Standard titled "Pre-Clearing and Remediation Drilling" (Hess, 2013).

Hollow-Stem Auger Borings

The hollow-stem auger borings were located approximately 10 feet outside of the LF1 limits on each of its four sides. Hand auger borings were installed within the LF1 limits and through the perimeter dike on each of its four sides. Hollow-stem and hand auger boring locations are shown on Figure 1.

Uni-Tech utilized track mounted Central Mine Equipment (CME) Model 750 and tractor CME Model 55LC drill rigs with 4.25-inch inside diameter hollow stem augers to advance the borings. Vane shear tests were performed and thin-walled "shelby" tube samples were collected in borings offset 5 to 7 feet away from each hollow-stem auger boring. Borings were installed in accordance with ASTM D6151. Below the "soft dig" depth, borings were continuously sampled with a split barreled sampler ("split-spoon") in accordance with ASTM D1586 or thin-walled tubes ("Shelby tube") were advanced in accordance with ASTM D1587. The split-spoon sampler was advanced through dike fill and underlying peat and native soils until standard penetration test (SPT) "N" values were greater than or equal to 10. The KEY field geologist field-screened the breathing zone and each split-spoon sample immediately upon opening with a photo-ionization detector (PID) calibrated and provided by Earth Systems. The materials encountered were classified by the KEY field geologist in accordance with ASTM D2488 using the Unified Soil Classification System (USCS). A physical description of each split spoon sample, standard penetration test "N-value," and field screening results were recorded and are presented on the boring logs. In-situ shear strength testing was generally conducted above and below the Shelby tube test locations in accordance with ASTM D2573. The vane shear testing apparatus was manufactured by Acker and utilized 2 and 3-5/8 inch diameter vanes and a 12 inch lower force arm. Split-spoon samples were obtained from each split-spoon, placed in glass jars, and sealed with lids to minimize moisture loss. The sample jars were maintained onsite until samples were selected for geotechnical laboratory testing and transported offsite to KEY's Carnegie, Pennsylvania office. Jarred soil samples that were not shipped from the Site for geotechnical laboratory testing were disposed of into IDW containers. Alternatively, material samples from consecutive split-spoons and with the same USCS classification based on the visual manual procedure were combined to form a single sample. Shelby tube samples were sealed and transported to KEY's Carnegie, Pennsylvania office for examination. After examination, split-spoon jar samples and Shelby tube samples were submitted to JLT Laboratories, Inc. of Canonsburg, Pennsylvania for geotechnical testing. Daily field activity reports of geotechnical investigation activities are provided in Appendix A. Results of the geotechnical laboratory testing are summarized on Table 1 and presented in Appendix B.

Lithology

The dominant lithology of LF1 generally consists of FILL material from the ground surface to approximately 13.1 to 14 feet below ground surface (ft-bgs). Below the FILL material, very dark gray to grayish brown silty clayey PEAT with trace to abundant organics is present to approximately 22.8 to 25.5 ft-bgs. Below the PEAT layer there is reddish brown to dark brown sand and rounded to angular gravel. A summary of the geotechnical SPTs and lithology of the LF1 is presented in cross sections A-A' and B-B' on Figures 2 and 3, respectively. Geotechnical boring logs with SPT data and USCS soil classifications are provided in Appendix C. Borings were abandoned under the direction of Earth Systems onsite personnel in accordance with applicable Earth Systems SOPs.

Hand Auger Borings

Hand auger borings were completed on top of the exterior perimeter dikes (Figure 1) to determine the thickness of the clay cover material and lithology of the underlying soil. The thickness of the clay cover material ranged from 0.7 to 1.34 ft in borings KHA18-5 and KHA18-7, respectively. Below the clay cover material, silty sand and gravel was encountered until refusal ranging from 5 to 6 ft-bgs in borings KHA18-5 and KHA18-6, respectively. Boring KHA18-2 was completed inside of the LF1 where silty clayey topsoil, with clay and brick fragments, was present to 3.5 ft-bgs. The water level inside the LF1 was encountered at 3 ft-bgs and precluded sample collection below 3.5 ft-bgs. Hand auger borings logs are included in Appendix C. Hand auger borings were abandoned under the direction of Earth Systems onsite personnel in accordance with applicable Earth Systems SOPs.

IDW Management

IDW that was generated from the drilling activities included soil cuttings and displaced groundwater. All IDW was drummed and staged inside the LF1 limits to be managed for offsite disposal by Earth Systems.

3.0 SITE SURVEY

The geotechnical boring locations were staked after installation and then surveyed by DPK Consulting Land Surveyors of Piscataway, New Jersey. Survey activities were conducted on August 1, 2018 to establish survey control and reference points, survey Site topography and physical features. The survey references the New Jersey State Plane Coordinate System, North American Datum of 1983 and North American Vertical Datum of 1988 (NAVD88). The grid coordinates and ground surface elevation for each boring are provided on the respective boring log.

4.0 REFERENCES

American Society for Testing and Materials International (ASTM):

- D1586-11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
- D1587-15 Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
- D2488-17 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)
- D2573-15 Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils
- D4220-14 Standard Practices for Preserving and Transporting Soil Samples
- D6151-15 Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

Earth Systems Environmental Engineering (Earth Systems), 2018. Project Health and Safety Plan (HASP), HESS Port Reading, Woodbridge Township, Middlesex County, New Jersey. February 23.

Hess, 2013. Standard protocol titled "Pre-Clearing and Remediation Drilling" prepared by Hess Corporate Environment, Health, Safety & Social Responsibility (EHS & SR) Organization, Remediation Department. November 21.

TABLES

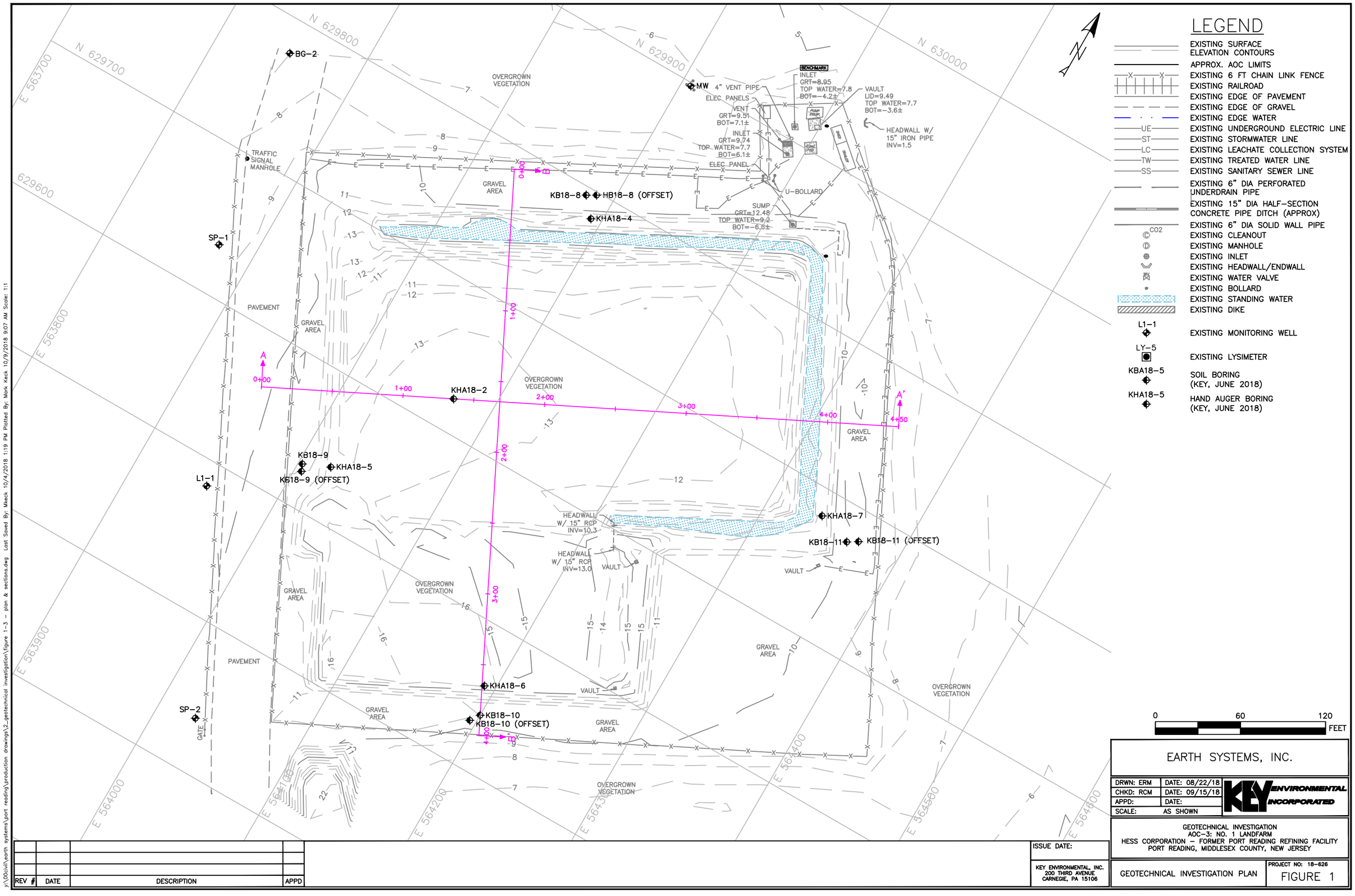
TABLE 1
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS
AOC-3: NO. 1 LANDFARM
HESS CORPORATION - FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

Boring ID	Sample ID	Sample Depth Interval (ft bgs)	PHYSICAL PROPERTIES											ENGINEERING PROPERTIES								
			Water Content ASTM D2216	Sieve ASTM D422		Hydrometer ASTM D422	Atterberg Limits (%) ASTM D4318			Bulk Density ASTM D4531	Specific Gravity ASTM D854	Organic Content ASTM D2974	USCS ASTM D2487 &/or ASTM D2488 (1)	Tube Log USACE	1-Dimensional Consolidation ASTM D4186			Consolidated Undrained Triaxial Compression ASTM D4767				Vane Shear ASTM D2573
			(%)	Passing No. 4 (%)	Passing No. 200 (%)		LL	PL	PI	(pcf)		(%)			e_o	max past eff stress (tsf)	C_c	c (psf)	Φ (degrees)	c' (psf)	Φ' (degrees)	(psf)
KB18-08 offset	ST1	17-19	75.29	100	97.9	51.3% silt 46.6% clay/colloids	51	40	11	96.3 wet / 55.0 dry	2.62	6.97	USCS OH (D2487) organic high plastic silt MH-OH (D2488)	X	1.9454	1.3	0.95					15 ft bgs: ≥ 3102 psf (peak), 2327 psf (remolded) 17 ft bgs: 2197 psf (peak), 776 psf (remolded)
KB18-08	SS-08	14-16		NT		NT	NP (3)					21.06	fine organic fibers									
KB18-08	SS-09	16-18		NT		NT	NP (3)					9.74	fine organics									
KB18-08	SS-10	18-20 (2 jars)		NT		NT	NP (3)					18.27	fibrous organics									
KB18-08	SS-11	20-22		NT		NT	NP (3)					6.55	very fine organics									
KB18-09 offset	ST1	17-19	63.55	100	97.7	50.5% silt 47.2% clay/colloids	55	41	14	101.7 wet / 62.7 dry	2.72	6.55	USCS OH (D2487) high plastic organic silt MH-OH (D2488)	X	1.8736	0.8	0.78	420	17.5	459	32.8	15 ft bgs: 2714 psf (peak), 905 psf (remolded) 17 ft bgs: 2585 psf (peak), 1422 psf (remolded)
KB18-09	SS-08	14-16		NT		NT	NP (3)					18.18	fibrous organics									
KB18-09	SS-10	18-20		NT		NT	NP (3)					12.6	fibrous organics									
KB18-09	SS-11	20-22		NT		NT	NP (3)					9.05	fibrous organics									
KB18-10 offset																						14 ft bgs: ≥ 543 psf (peak), 362 psf (remolded) 16.5 ft bgs: ≥ 543 psf (peak), 453 psf (remolded)
KB18-10	SS-08	14-16 'peat' jar		NT		NT	NP (3)					26.86	fibrous organics									
KB18-10	SS-08	14-16 'silty clay' jar		(2)		(2)	(2)					7.97	very fine organics									
KB18-10	SS-09	16-18		(2)		(2)	(2)					6.63	fibrous organics									
KB18-10	SS-10	18-20		(2)		(2)	(2)					7.8	fibrous organics									
KB18-11 offset																						14 ft bgs: 1965 psf (peak), 776 psf (remolded) 16 ft bgs: 1422 psf (peak), 646 psf (remolded)
KB18-11	SS-07	12-14 'peat' jar		NT		NT	NP (3)					34.16	fibrous organics									
KB18-11	SS-08	14-16		NT		NT	NP (3)					6.55	very fine organics									
KB18-11	SS-09	16-18		NT		NT	NP (3)					6.76	very fine organics									
KB18-11	SS-10	18-20		NT		NT	NP (3)					10.59	very fine organics									
KB18-11	SS-11	20-22		NT		NT	NP (3)					14.74	very fine organics									
KB18-11	SS-12	22-24		NT		NT	NP (3)					11.03	very fine organics									
KHA18-4	KHA18-4	shallow clay	24.8	100	84.7	22.1% silt 62.6% clay/colloids	(2)						ML									

ASTM - American Society for Testing and Materials International.
NP - Non plastic.
NT - Not tested.
USCS - Unified Soil Classification System.

Notes
(1) Classification for engineering purposes (USCS) based on laboratory test data. For description and identification based on visual/manual procedure performed in the field refer to boring log.
(2) Sample size inadequate to perform test.
(3) NP due to organic content.
(4) Refer to laboratory test results.

FIGURES



LEGEND

- EXISTING SURFACE ELEVATION CONTOURS
- APPROX. AOC LIMITS
- EXISTING 6 FT CHAIN LINK FENCE
- EXISTING RAILROAD
- EXISTING EDGE OF PAVEMENT
- EXISTING EDGE OF GRAVEL
- EXISTING EDGE WATER
- UE — EXISTING UNDERGROUND ELECTRIC LINE
- ST — EXISTING STORMWATER LINE
- LC — EXISTING LEACHATE COLLECTION SYSTEM
- TW — EXISTING TREATED WATER LINE
- SS — EXISTING SANITARY SEWER LINE
- EXISTING 6" DIA PERFORATED UNDERDRAIN PIPE
- EXISTING 15" DIA HALF-SECTION CONCRETE PIPE DITCH (APPROX)
- EXISTING 6" DIA SOLID WALL PIPE
- CO2 EXISTING CLEANOUT
- EXISTING MANHOLE
- EXISTING INLET
- EXISTING HEADWALL/ENDWALL
- EXISTING WATER VALVE
- EXISTING BOLLARD
- EXISTING STANDING WATER
- EXISTING DIKE
- L1-1 EXISTING MONITORING WELL
- LY-5 EXISTING LYSIMETER
- KBA18-5 SOIL BORING (KEY, JUNE 2018)
- KHA18-5 HAND AUGER BORING (KEY, JUNE 2018)

0 60 120 FEET

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 08/22/18	KEY ENVIRONMENTAL INCORPORATED	
CHKD: RCM	DATE: 09/15/18		
APPD:	DATE:		
SCALE:	AS SHOWN		

GEOTECHNICAL INVESTIGATION
AOC-3: NO. 1 LANDFARM
HESS CORPORATION – FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

GEOTECHNICAL INVESTIGATION PLAN

PROJECT NO: 18-626

FIGURE 1

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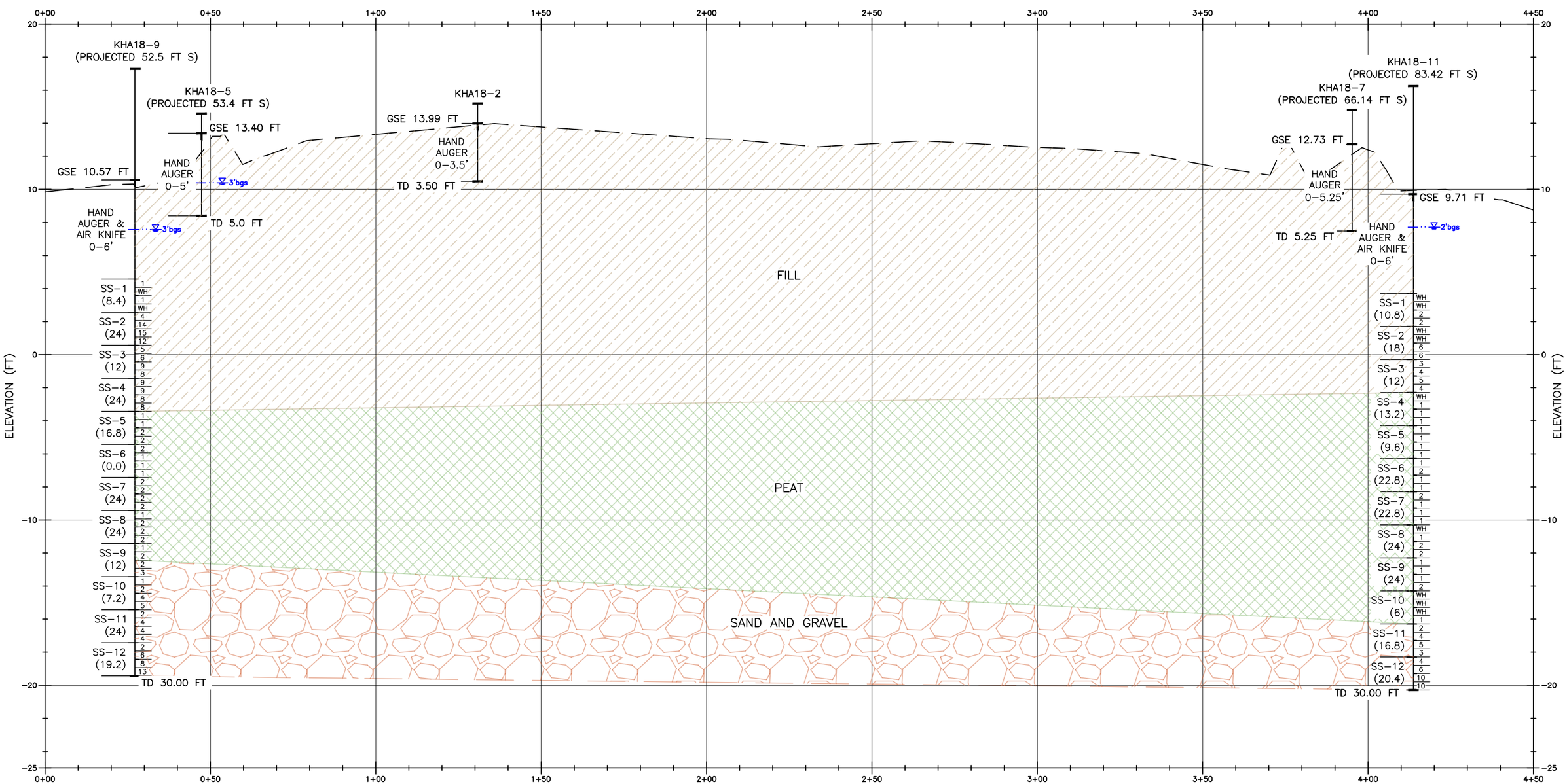


LEGEND

- EXISTING GROUND SURFACE
- WATER LEVEL AT TIME OF BORING
- T — TOP OF BORING/ GROUND SURFACE
- SS-1 — SPLIT SPOON SAMPLE ID
- (8.4) — RECOVERY OF SPLIT SPOON IN INCHES OUT OF 24"
- 1 WH 1 WH — STANDARD PENETRATION TEST BLOW COUNT VALUES
- FILL
- PEAT
- SAND AND GRAVEL
- GSE — GROUND SURFACE ELEVATION
- TD — TOTAL DEPTH

1 / FIG 1 — CROSS-SECTION A-A'

V: 0 6 12 FEET

H: 0 30 60 FEET

NOTES:

1. REFER TO FIGURE 1 FOR BORING LOCATION PLAN.
2. OFFSET BORINGS ARE NOT SHOWN.
3. LITHOLOGIC INTERVALS INDICATED HEREON MAY DIFFER FROM BORING LOGS. LITHOLOGY INDICATED HEREON REPRESENTS A CONSERVATIVE INTERPRETATION OF BORING LOGS FOR PURPOSES OF GEOTECHNICAL EVALUATION.

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

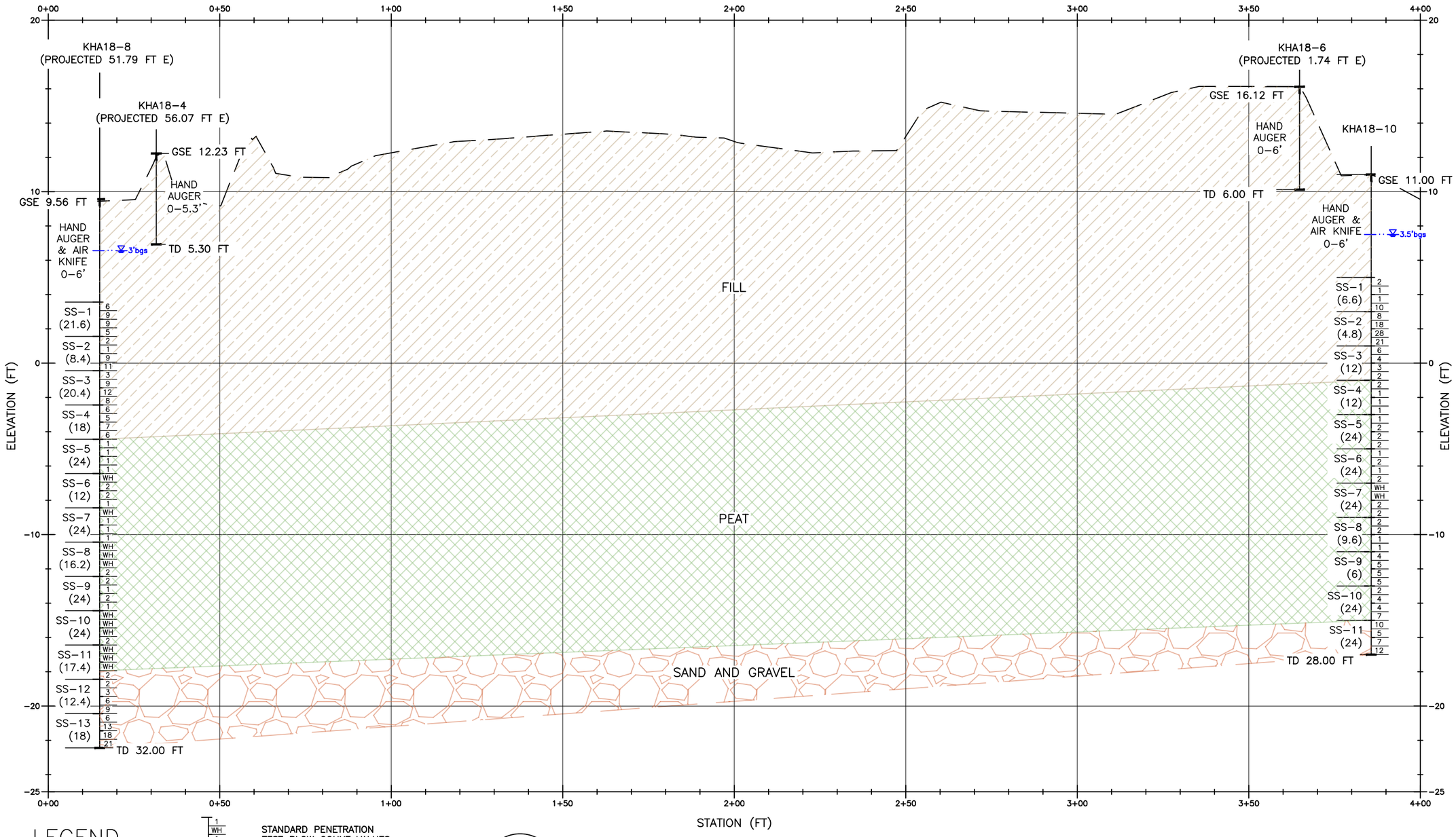
DRWN: ERM	DATE: 08/22/18	KEY ENVIRONMENTAL INCORPORATED
CHKD: RCM	DATE: 09/15/18	
APPD:	DATE:	
SCALE:	AS SHOWN	

GEOTECHNICAL INVESTIGATION
AOC-3: NO. 1 LANDFARM
HESS CORPORATION – FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

CROSS SECTION A-A'

PROJECT NO: 18-626

FIGURE 2



LEGEND

——— ———	EXISTING GROUND SURFACE
——▼—·—·	WATER LEVEL AT TIME OF BORING
T	TOP OF BORING/ GROUND SURFACE
SS-1	SPLIT SPOON SAMPLE ID
(8.4)	RECOVERY OF SPLIT SPOON IN INCHES OUT OF 24"
1 WH 1 WH	STANDARD PENETRATION TEST BLOW COUNT VALUES
	FILL
	PEAT
	SAND AND GRAVEL
GSE	GROUND SURFACE ELEVATION
TD	TOTAL DEPTH

2
FIG 1

CROSS-SECTION B-B'

NOTES:

1. REFER TO FIGURE 1 FOR BORING LOCATION PLAN.
2. OFFSET BORINGS ARE NOT SHOWN.
3. LITHOLOGIC INTERVALS INDICATED HEREON MAY DIFFER FROM BORING LOGS. LITHOLOGY INDICATED HEREON REPRESENTS A CONSERVATIVE INTERPRETATION OF BORING LOGS FOR PURPOSES OF GEOTECHNICAL EVALUATION.

V: 0 6 12 FEET
H: 0 30 60 FEET

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 08/22/18	KEY ENVIRONMENTAL INCORPORATED	
CHKD: RCM	DATE: 09/15/18		
APPD:	DATE:		
SCALE:	AS SHOWN		

GEOTECHNICAL INVESTIGATION
AOC-3: NO.1 LANDFARM
HESS CORPORATION – FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

CROSS SECTION B-B'

PROJECT NO: 18-626
FIGURE 3

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APPENDIX A

Daily Field Activity Reports

DAILY FIELD ACTIVITY LOG
GEOTECHNICAL SAMPLING PROJECT #18626-01-02
EARTH SYSTEMS, INC.

LAND FARM No. 1, HESS/BUCKEYE TERMINAL, PORT READING, NJ

OVERSIGHT:	Tracey Smith
WEATHER: *Temperature* *Precipitation*	Cloudy 59°F – 71°F <0.10 inches
CONTRACTORS AND PERSONNEL ON-SITE: *Key Environmental Inc. (KEY)* *Earth Systems* *Unitech Drilling (Earth Systems Subcontractor)*	 Tracey Smith – Geologist Bill Williams – Geologist Butch – Driller Warren – Helper
EQUIPMENT ON-SITE: *Unitech Drilling* *Earth Systems*	 CME 55 LC Track Rig and Water Truck Support Truck Ingersoll Rand Air Compressor 175 Utilivac VE 75 with air knife and vacuum attachments Mini Rae 3000 PID meter

ACTIVITIES COMPLETED:

1. KEY on-site at 0730.
2. Earth Systems safety tailgate meeting conducted by Bill Williams. Topics covered included proper PPE, site history/condition, and operating drilling equipment.
3. Clear KB18-10 location with hand auger and air knife to 6 ft-bgs.
4. Drill and split spoon sample KB18-10 to sand layer underlying peat layer with N≥10.
5. Offset 5 ft southwest of KB18-10 location, drill HSA to 10 ft-bgs, stop to confirm vane shear and Shelby tube collection depths for Thursday.
6. Abandon KB18-10 location with cuttings and bentonite.
7. Clear KB18-11 location with hand auger and air knife to 6 ft-bgs.
8. KEY off-site at 1545.

WORK PLANNED:

1. Complete vane shear testing and Shelby tube collection at KB18-10 offset location.
2. Drill and split spoon sample KB18-11 to sand layer underlying peat layer.
3. Offset from KB18-11 sampling location and perform vane shear test and collect Shelby tube.

NOTES/ONSITE ISSUES:

1. Earth Systems and Hess have requested that all work onsite Wednesday June 6, 2018 be halted during site executive site visit.
2. Running sands from approx. 3-10 ft-bgs at KB18-10, used bentonite slurry to keep sands from running into hollow-stem augers.
3. PID ambient background/breathing zone readings ranged from 0.1-0.3 ppm (likely from surrounding terminal areas).
4. KB18-10 soil was non-detect with PID meter.

PHOTOS ATTACHED:	Yes.

Oversight Signature: *Tracey Smith*

Date: **June 05, 2018**

Photo Log

	
Photo 1 – Unitech drillers clearing KB18-10 location to 6 ft-bgs.	Photo 2 – KB18-10 cleared to 6 ft-bgs with air knife.
	
Photo 3 – KB18-10 split spoon sample 16-18 ft-bgs showing silty clay material found between peat layers.	Photo 4 – KB18-10 split spoon sample 24-26 ft-bgs showing peat material (top - abundant wood fibers), silty clay material (middle), and underlying sand material (bottom).
	
Photo 5 – KB18-10 split spoon sample 26-28 ft-bgs showing more of sand material with N value of 12.	Photo 6 – Boring offset 5 ft to the southwest of KB18-10 cleared to 6 ft-bgs.

	
Photo 7 – KB18-11 cleared to 6 ft-bgs with air knife.	

DAILY FIELD ACTIVITY LOG
MONITORING WELL INSTALLATION PROJECT #18626-01-02
EARTH SYSTEMS, INC.

LAND FARM No. 1, HESS/BUCKEYE TERMINAL, PORT READING, NJ

OVERSIGHT:	Tracey Smith
WEATHER: *Temperature* *Precipitation*	Cloudy 59°F – 71°F <0.10 inches
CONTRACTORS AND PERSONNEL ON-SITE: *Key Environmental Inc. (KEY)* *Earth Systems* *Unitech Drilling (Earth Systems Subcontractor)*	 Tracey Smith – Geologist Bill Williams – Geologist Technician Butch – Driller Warren – Helper Mike – Driller Eugene - Helper
EQUIPMENT ON-SITE: *Unitech Drilling* *Earth Systems (Pine Rental)*	 CME 55 LC Track Rig and Water Truck Support Truck CME 750 and Semi Transportation trailer Ingersoll Rand Air Compressor 175 Utilivac VE 75 with air knife and vacuum attachments Mini Rae 2000 PID meter

ACTIVITIES COMPLETED:

1. KEY on-site at 0715.
2. Butch, Warren, and Bill clear KB18-11, KB18-9, KB18-8 sampling (split spoon) and offset (vane shear and Shelby tubes) with hand auger and air knife to 6 ft-bgs.
3. Mike and Eugene complete vane shear testing at 13 and 15.5 ft-bgs and collect Shelby tubes from 17-19 ft-bgs and 19-21 ft-bgs in KB18-10 offset boring location.
4. Mike and Eugene drill and split spoon sample KB18-11 to sand layer underlying peat layer.
5. Offset 5 ft southeast of KB18-11 and set up CME 750 for vane shear and Shelby tube collection.
6. Abandon KB18-11 location with cuttings and bentonite.
7. KEY off-site at 1500.

WORK PLANNED:

1. Complete vane shear testing and Shelby tube collection at KB18-11 offset boring location.
2. Drill and split spoon sample KB18-8.
3. Offset from KB18-8 sampling location and perform vane shear test and collect Shelby tube.

NOTES/ONSITE ISSUES:

1. None.

PHOTOS ATTACHED:	Yes.

Oversight Signature: Tracey Smith

Date: **June 07, 2018**

Photo Log

	
Photo 1 – Drillers completed vane shear testing on KB18-11 offset boring location.	Photo 2 – Shelby tubes collected from KB18-10 offset boring location from 17-21 ft-bgs.
	
Photo 3 – Drilling HSA and split spoon sampling KB18-11.	Photo 4 – KB18-11 split spoon sample 20-22 ft-bgs showing silty clay portion of peat material.

DAILY FIELD ACTIVITY LOG
GEOTECHNICAL SAMPLING PROJECT #18626-01-02
EARTH SYSTEMS, INC.

LAND FARM No. 1, HESS/BUCKEYE TERMINAL, PORT READING, NJ

OVERSIGHT:	Tracey Smith
WEATHER: *Temperature* *Precipitation*	Cloudy 57°F – 83°F <0.10 inches
CONTRACTORS AND PERSONNEL ON-SITE: *Key Environmental Inc. (KEY)* *Earth Systems* *Unitech Drilling (Earth Systems Subcontractor)*	 Tracey Smith – Geologist Bill Williams – Geologist Butch – Driller Warren – Helper
EQUIPMENT ON-SITE: *Unitech Drilling* *Earth Systems (Pine Rental)*	 CME 750 and Semi Transportation trailer Support Truck Mini Rae 2000 PID meter

ACTIVITIES COMPLETED:

1. KEY on-site at 0630 a.m.
2. Earth Systems safety tailgate meeting conducted by Bill Williams. Topics covered included proper PPE, contamination, working in hot temperatures, and operating drilling equipment.
3. Offset 5 ft southeast of KB18-11 and set up CME 750 for vane shear and Shelby tube collection.
4. Complete vane shear testing at 13 and 15 ft-bgs and collect Shelby tubes from 17-19 ft-bgs and 20-22 ft-bgs from KB18-11 offset boring location.
5. Drill and continuously sample KB18-8 to sand layer underlying peat layer.
6. Abandon KB18-8 borehole with bentonite and cuttings slurry.
7. KEY off-site at 1430 a.m.
8. Demobilize to Pittsburgh, PA.

WORK PLANNED:

1. Complete vane shear testing and Shelby tube collection at KB18-8 offset location.
2. Drill and split spoon sample KB18-9.
3. Offset from KB18-9 sampling location and perform vane shear test and collect Shelby tube.

NOTES/ONSITE ISSUES:

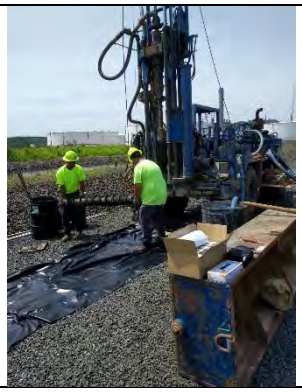
1. Shelby tubes at KB18-11 offset boring location from 17-19 ft-bgs and 20-22 ft-bgs had zero recovery.
2. PID ambient background/breathing zone readings were 0.00 ppm.
3. PID readings from KB18-11 soil samples ranged from 0.0-1.6ppm.

PHOTOS ATTACHED:	Yes.

Oversight Signature: *Tracey Smith*

Date: **June 08, 2018**

Photo Log

	
Photo 1 – Drillers completing vane shear testing on KB18-11 offset boring location.	Photo 2 – Setting up to drill and sample KB18-8 with CME 750.
	
Photo 3 – Characteristic peat material (left/bottom) with abundant wood fibers/roots and silty clay material with trace fibers and shell fragments (right/top) in split spoon sample 18-20 ft-bgs in KB18-8.	Photo 4 – Sand and gravel material underneath peat material in KB18-8 split spoon sample 28-30 ft-bgs (top) and 30-32 ft-bgs (bottom).

DAILY FIELD ACTIVITY LOG
GEOTECHNICAL SAMPLING PROJECT #18626-01-02
EARTH SYSTEMS, INC.

LAND FARM No. 1, HESS/BUCKEYE TERMINAL, PORT READING, NJ

OVERSIGHT:	Tracey Smith
WEATHER: *Temperature* *Precipitation*	Overcast, scattered rain showers and thunderstorms 65°F – 77°F <0.10 inches
CONTRACTORS AND PERSONNEL ON-SITE: *Key Environmental Inc. (KEY)* *Earth Systems* *Unitech Drilling (Earth Systems Subcontractor)*	 Tracey Smith – Geologist Bill Williams – Geologist Jay – Driller Gene – Helper
EQUIPMENT ON-SITE: *Unitech Drilling* *Earth Systems (Pine Rental)*	 CME 750 and Semi Transportation trailer Support Truck Mini Rae 2000 PID meter

ACTIVITIES COMPLETED:

1. KEY on-site at 0715.
2. Earth Systems safety tailgate meeting conducted by Bill Williams. Topics covered included proper PPE, site conditions/history, thunderstorm protocol, and operating drilling equipment.
3. Drill and continuously sample KB18-9 to sand layer underlying peat layer.
4. Offset 5 ft southwest of KB18-9 and set up CME 750 for vane shear and Shelby tube collection.
5. Complete vane shear testing at KB18-9 offset boring location at 14-15 ft-bgs and 16-17 ft-bgs and collect Shelby tube from 17-19 ft-bgs.
6. Abandon KB18-9 offset boring location borehole with bentonite slurry.
7. Sketch layout of underground utilities around treatment shed with approximate dimensions.
8. Drill hollow stem auger and complete vane shear testing at KB18-8 offset boring location at 14-15 ft-bgs.
9. KEY off-site at 1600.

WORK PLANNED:

1. Complete vane shear testing and Shelby tube collection at KB18-8 offset boring location.
2. Complete hand auger borings on landfarm perimeter dike and interior to identify material type via USCS visual/manual methodology.

NOTES/ONSITE ISSUES:

1. Shelby tube at KB18-9 offset boring had 100% recovery, only one tube was collected.
2. PID ambient background/breathing zone readings were 0.2-2.3 ppm, likely from petroleum operations across the street.
3. PID readings from KB18-9 soil samples ranged from 0.0-4.7 ppm.

PHOTOS ATTACHED:	Yes.

Oversight Signature: Tracey Smith

Date: **June 13, 2018**

Photo Log

Photo 1 – Setting up to drill and sample KB18-9 with CME 750.

Photo 2 – Setting up to drill and sample KB18-8 with CME 750.

Photo 3 – Characteristic peat material with abundant wood fibers/roots and silty clay material with trace shell fragments (right) in split spoon sample 14-16 ft-bgs in KB18-9.

Photo 4 – Sand and gravel material below peat material in KB18-9 split spoon sample 28-30 ft-bgs.

DAILY FIELD ACTIVITY LOG
GEOTECHNICAL SAMPLING PROJECT #18626-01-02
EARTH SYSTEMS, INC.

LAND FARM No. 1, HESS/BUCKEYE TERMINAL, PORT READING, NJ

OVERSIGHT:	Tracey Smith
WEATHER: *Temperature* *Precipitation*	Sunny 61°F – 84°F <0.10 inches
CONTRACTORS AND PERSONNEL ON-SITE: *Key Environmental Inc. (KEY)* *Earth Systems* *Unitech Drilling (Earth Systems Subcontractor)*	 Tracey Smith – Geologist Bill Williams – Geologist Eugene – Driller Carl H. – Helper
EQUIPMENT ON-SITE: *Unitech Drilling* *Earth Systems (Pine Rental)*	 CME 750 and Semi Transportation trailer Support Truck Mini Rae 2000 PID meter

ACTIVITIES COMPLETED:

1. KEY on-site at 0715.
2. Earth Systems safety tailgate meeting conducted by Bill Williams. Topics covered included proper PPE, site conditions/history, and operating drilling equipment.
3. Complete vane shear testing at KB18-8 offset boring location at 16-17 ft-bgs and collected Shelby tube from 17-19 ft-bgs.
4. Abandon KB18-8 offset boring location borehole with bentonite slurry.
5. Complete hand auger borings KHA18-2, KHA18-4, KHA18-5, KHA18-6, and KHA18-7.
6. KEY off-site at 1300.

WORK PLANNED:

1. Complete site survey of topography, geotechnical borings locations, hand auger locations, and treatment system aspects.

NOTES/ONSITE ISSUES:

1. Shelby tube at KB18-8 offset boring location had 100% recovery, only one tube was collected.

PHOTOS ATTACHED:	Yes.

Oversight Signature: Tracey Smith

Date: **June 14, 2018**

Photo Log

	
Photo 1 – Hand auger collection at KHA18-4	Photo 2 – Hand auger boring abandoned with cuttings, top 2 feet completed with granular bentonite at KHA18-6.
	
Photo 3 – KHA18-7 location with stake (left middle) and KB18-11 (right middle).	

DAILY FIELD ACTIVITY LOG
SURVEY KICK-OFF #18626-01-02
EARTH SYSTEMS, INC.

LAND FARM No. 1, HESS/BUCKEYE TERMINAL, PORT READING, NJ

Kick-off By:	Vamsee Veera
WEATHER: *Temperature* *Precipitation*	Overcast, showers about 75°F Forecast 0.15 inches
CONTRACTORS AND PERSONNEL ON-SITE: *Key Environmental Inc. (KEY)* *Earth Systems* *DLP Consulting, LLC (Earth Systems Subcontractor)*	 Vamsee Veera Ryan Carr Ken Deluca, Juliet Lisky
EQUIPMENT ON-SITE: *DLP Consulting, LLC*	 Surveying instruments/equipment.

ACTIVITIES COMPLETED:

1. KEY on-site at 0550.
2. Earth Systems representative Ryan Carr escorted KEY and DLP representatives to Landfarm No.1 area.
3. KEY, DLP and Earth Systems walk around Landfarm No.1 gravel access areas and berms to identify the KB18 series borings and KHA18 series hand-auger locations, and utility marking areas. Earth Systems indicated that the located were previously surveyed and data will be forward to KEY.
4. KEY off-site at 0750.

WORK PLANNED:

1. Kick-off survey for topography, geotechnical borings locations, hand auger locations, and treatment system aspects.

NOTES/ONSITE ISSUES:

1. Landfarm area inside the dike overgrown with vegetation. Earth Systems to contact landscaper for cutting/mowing. Earth System anticipates surveyor may need to come back tomorrow or when feasible.

PHOTOS ATTACHED:	Yes.

Oversight Signature: *Vamsee Veera*

Date: **August 1, 2018**

Photo Log

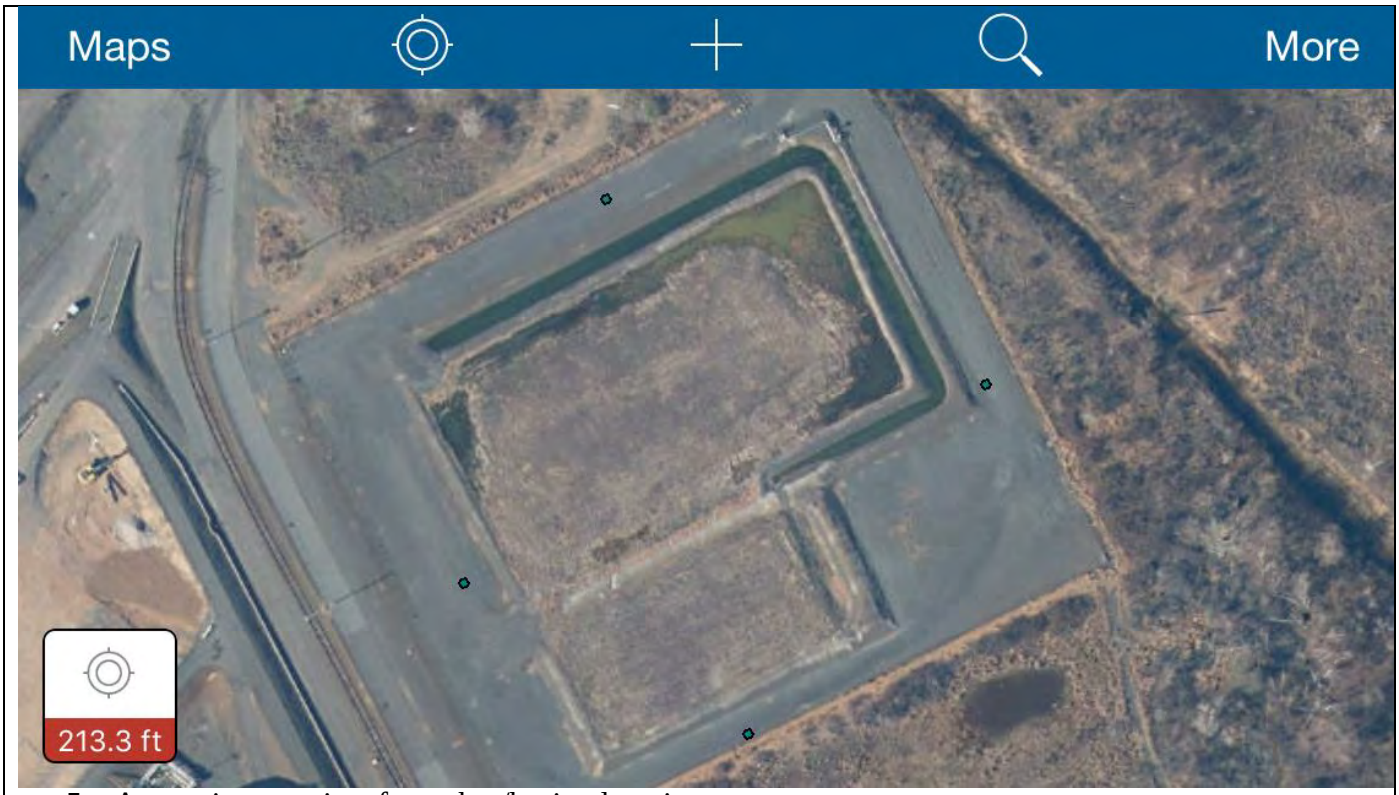
1. Area showing KB18-8 and KHA18-4.

2. Area showing KB18-9 and KHA18-5.

3. Area showing KB18-11 and KHA18-7.

4. Area showing KB18-10 and KHA18-6.

4. Area pointing to KHA18-2.



5. Approximate points for stakes/boring location.

APPENDIX B

Geotechnical Laboratory Data

JLT Laboratories, Inc.
Geotechnical, Geosynthetic and Materials Testing and Research

938 South Central Avenue
Canonsburg, Pennsylvania, 15317
Tel: 724-746-4441 Fax: 724-745-4261
e-mail: jboschuk@jltlabs.com
www.jltlabs.com

July 9, 2018
18LS3685.01

Key Environmental, Inc.
200 Third Avenue
Carnegie, PA 15106

Attn: Robert Mertz

RE: GEOTECHNICAL TEST RESULTS
NO. 1 LANDFARM – PORT READING, NJ (18626 01 02)

Dear Mr. Mertz:

Submitted herein is various testing performed on seventeen (17) jar samples and two (2) Shelby Tubes for the above referenced project. Where applicable, testing was performed per ASTM Standards while subject to JLT's internal QA / QC and data validation procedures.

We appreciate the opportunity to provide our services and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

JLT LABORATORIES, INC.

John Boschuk, Jr., P.E., C.F.E.
President

cc: Patty Lane - PDF Invoices Only

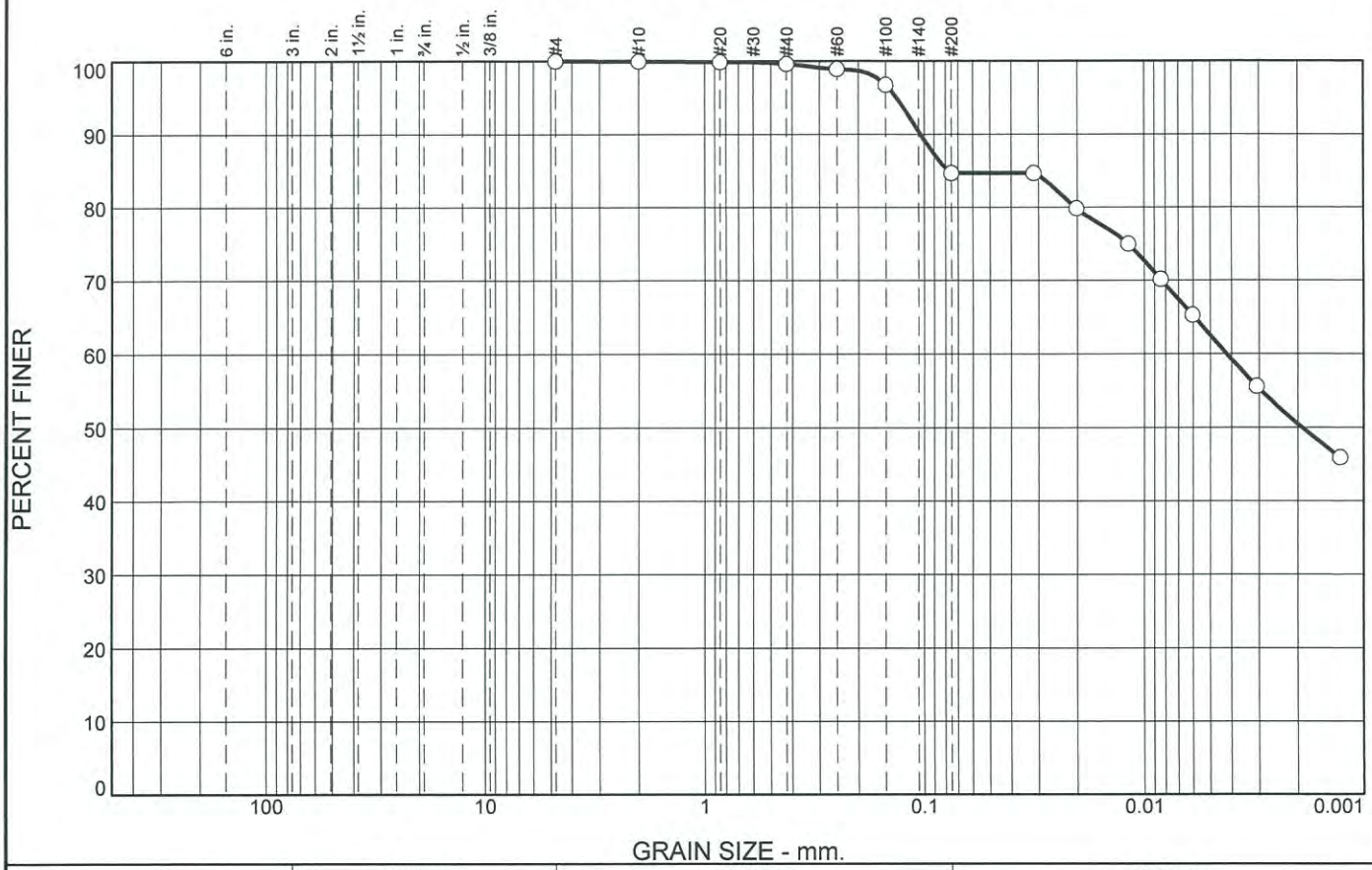
Enclosures
JB\mlb
MSWord\letter\18179
Inv# 6995

Key Environmental, Inc. **JLT Job No: 18LS3685**
No. 1 Landfarm, Port Reading, NJ **Date: 6/29/2018**

Sample ID	Depth	Sieve	Hydrometer	Atterberg Limits	Organic Content (%)	Visual Classification	Pan ID (A)
KB18-08 SS-08	14-16	Not Requested	Not Requested	Not Requested	21.06	Fine Org - Fibers	R1
KB18-08 SS-09	16-18	Not Requested	Not Requested	Not Requested	9.74	Fine Organics	6
KB18-08 SS-10	18-20	Not Requested	Not Requested	Not Requested	18.27	Fibrous Organics	33
KB18-08 SS-11	20-22	Not Requested	Not Requested	Not Requested	6.55	VF Organics	3
KB18-09 SS-08	14-16	Not Requested	Not Requested	Not Requested	18.18	Fibrous Organics	EX77
KB18-09 SS-10	18-20	Not Requested	Not Requested	Not Requested	12.6	Fibrous Organics	A7
KB18-09 SS-11	20-22	Not Requested	Not Requested	Not Requested	9.05	Fibrous Organics	9
KB18-10 SS-08	14-16 Peat Jar	Not Requested	Not Requested	Not Requested	26.86	Fibrous Organics	H18
KB18-10 SS-08	14-16 Silty Clay Jar	Only Organics Left - Not Enough Sample for Atterbergs			7.97	VF Organics	A54
KB18-10 SS-09	16-18	Only Organics Left - Not Enough Sample for Atterbergs			6.63	Fibrous Organics	R110
KB18-10 SS-10	18-20	Only Organics Left - Not Enough Sample for Atterbergs			7.8	Fibrous Organics	A79
KB18-11 SS-07	12-14 Peat Jar	Not Requested	Not Requested	Not Requested	34.16	Fibrous Organics	AA8
KB18-11 SS-08	14-16	Only Organics Left - Not Enough Sample for Atterbergs			6.55	VF Organics	43
KB18-11 SS-09	16-18	Only Organics Left - Not Enough Sample for Atterbergs			6.76	VF Organics	R171
KB18-11 SS-10	18-20	Only Organics Left - Not Enough Sample for Atterbergs			10.59	VF Organics	R220
KB18-11 SS-11	20-22	Only Organics Left - Not Enough Sample for Atterbergs			14.74	VF Organics	F
KB18-11 SS-12	22-24	Only Organics Left - Not Enough Sample for Atterbergs			11.03	VF Organics	10

(A): The Pans for the wash sieves were saved. They contin fibrous organics or most passed the 200 sieve as ultra fine organics. Photos can be provided.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.3	14.9	22.1	62.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	99.6		
#60	98.9		
#100	96.8		
#200	84.7		

* (no specification provided)

Material Description

Shallow Clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1034 D_{85}= 0.0772 D_{60}= 0.0042
D_{50}= 0.0019 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

As-Rec'd M/C = 24.8%
No Enough Sample for Atterberg Limits

Location: Port Reading, NJ
Sample Number: KHA18-4

Date: 06/28/2018

JLT Laboratories, Inc.

Canonsburg, PA

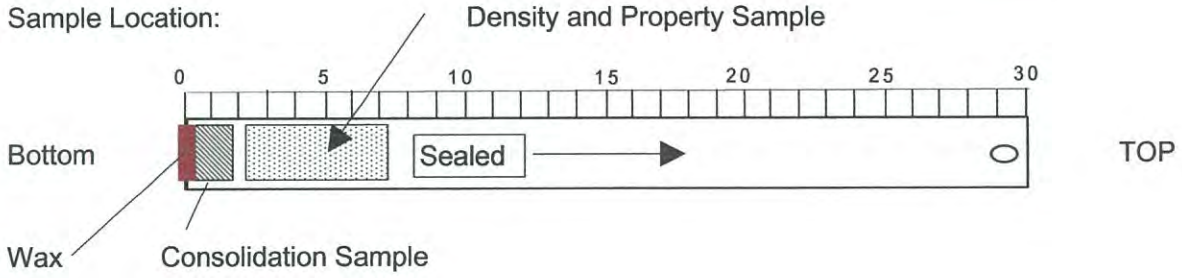
Client: Key Environmental, Inc.
Project: No. 1 Landfarm, Port Reading, NJ
Key Project No: 18626.01.02
Project No: 18LS3685.01 **Figure**

Tested By: AE **Checked By:** JB

DENSITY AND MOISTURE OF TUBE SAMPLES

Client:	Key Environmental	**Job No. :**	18LS3685
Project:	No 1 Land Farm Port Reading , NJ	**Date :**	06/29/2018
Material ID:	Organic Silts	**Perf'd By :**	AE
Tube ID:	Tube KB18-08 Offset ST-1 17 to 19 ft	**Chk'd By :**	JBJr

Sample Location:

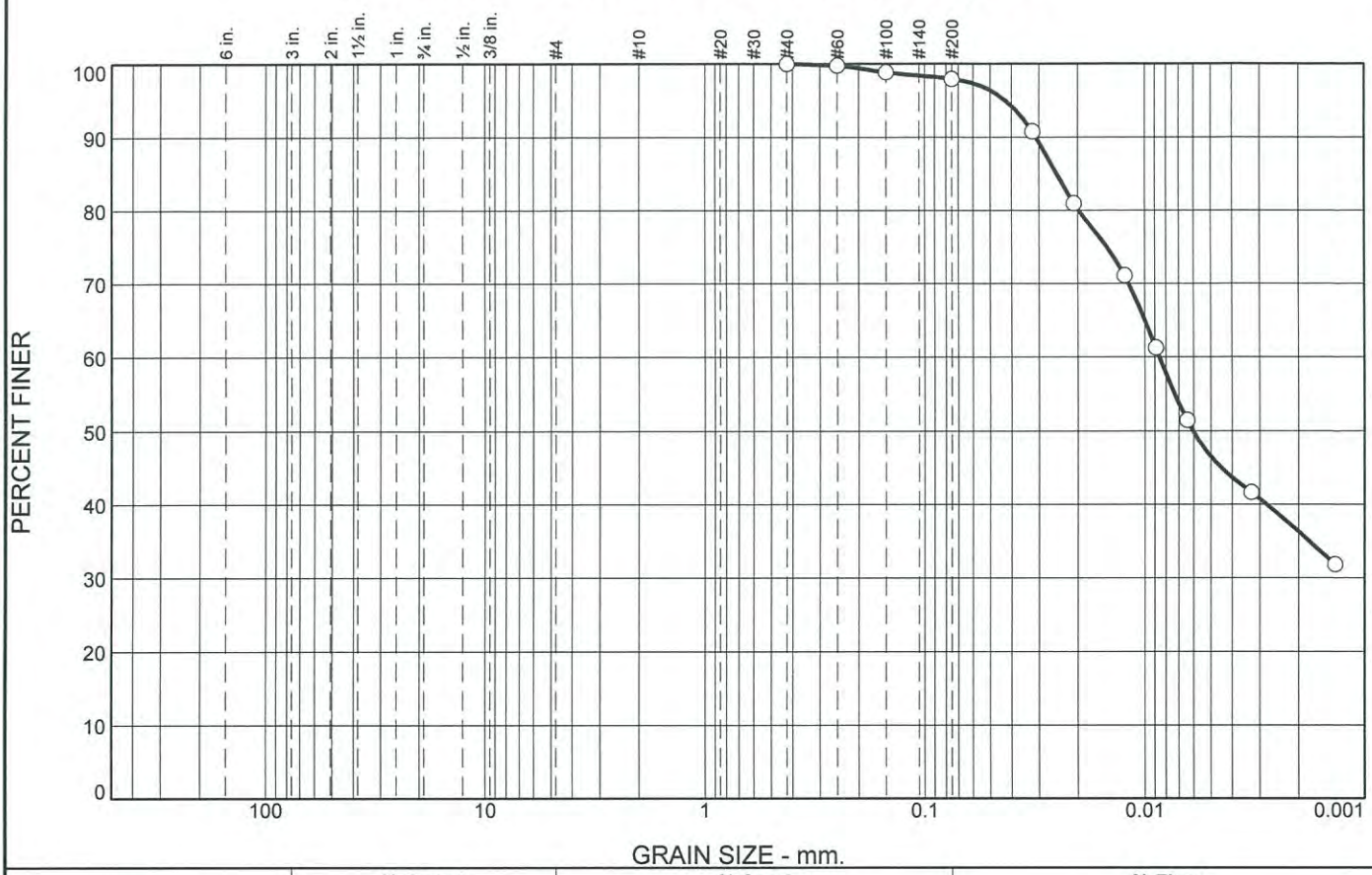


Moisture - Density Determination

Tare ID	AC-1		
Section Length :	4.88		inches
Inside Diameter of Sample:	2.84		inches
Wt. of Wet Soil + Tube + Tare	1144.4		grams
Wt. of Dry Soil + Tube + Tare	808.4		grams
Weight of Tube Section only	346.4		grams
Wt. of Tare only	15.7		grams
Weight of Wet Soil only	782.3		grams
Weight of Dry Soil Only	446.3		grams
Weight of Water in Sample	336.0		grams
Moisture Content:	*75.29*		*%*
Bulk Wet Density:	*96.3*		*pcf*
Bulk Dry Density :	*55.0*		*pcf*
Specific Gravity :	*2.62*		

JLT Laboratories, Inc.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	2.1	51.3	46.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#60	99.8		
#100	98.9		
#200	97.9		

* (no specification provided)

Material Description

Off Set
Shelby Tube

Atterberg Limits

PL= 40 LL= 51 PI= 11

Coefficients

D_{90}= 0.0309 D_{85}= 0.0249 D_{60}= 0.0085
D_{50}= 0.0060 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= OH AASHTO=

Remarks

Organic Content = 6.97% / Specific Gravity = 2.62
Visual Classification: Organic High Plastic Silt MH-OH

Location: Port Reading, NJ
Sample Number: KB18-08 ST-1 **Depth:** 17-19 **Date:** 06/29/2018

JLT Laboratories, Inc.

Canonsburg, PA

Client: Key Environmental, Inc.
Project: No. 1 Landfarm, Port Reading, NJ
Key Project No: 18626.01.02
Project No: 18LS3685.01 **Figure**

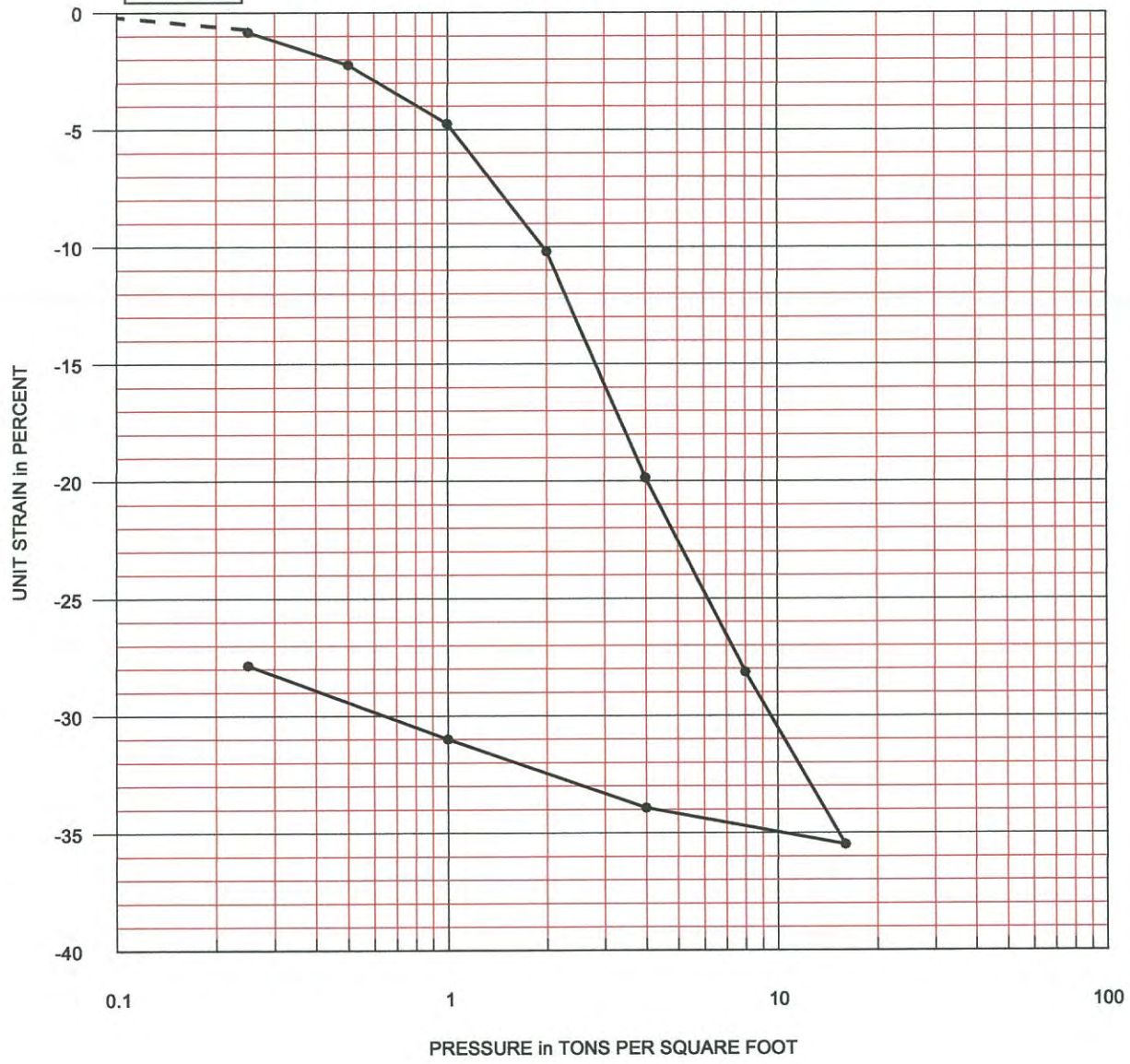
Tested By: AE **Checked By:** JB

CONSOLIDATION TEST RESULTS

STRAIN vs PRESSURE

0 to 1/4 tsf

ASTM D-2435



MATERIAL DESCRIPTION:		
Shelby Tube		
1AOC-C1 Tank		
Non Firous Peat		
TEST SPECIMEN PROPERTIES	INITIAL	FINAL
Water Content, %	73.65	44.94
Void Ratio	1.9454	1.0258
Saturation, %	99.9	100.0
Sample Height, inches	1.0000	0.6878
Unit Dry Weight, pcf	55.96	81.36
Sample Diameter, inches	2.5000	2.5000
Liquid Limit, %	51	
Plastic Limit , %	40	
Plasticity Index, %	11	
Specific Gravity	2.64	Assumed

CONSOLIDATION PROPERTIES				
Compression Index			Preconsolidation Stress,tsf	
Recompression Index			Existing Overburden Stress,tsf	
Swell Index				

CONSOLIDATION TEST RESULTS

Client:	Key Environmental	Project No:	18LS3685.01
Project :	No 1 Land Farm Port Reading , NJ	Print Date :	07/06/2018
Boring:	KB18-08	Perf'd By:	MLB
Sample :	Offset ST-1	Chk'd By:	JBJr.
Depth:	17 to 19 ft		

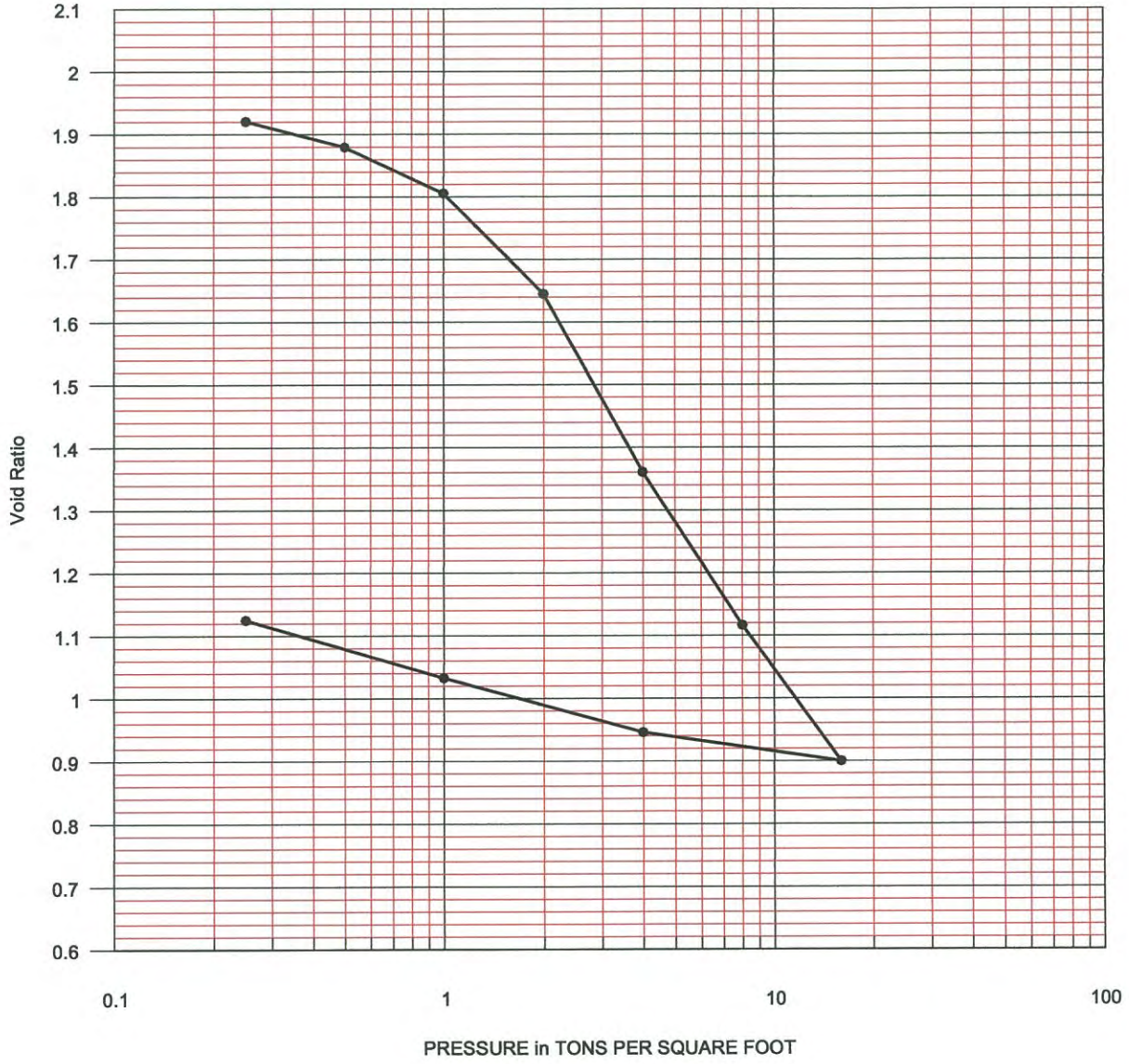
JLT Laboratories, Inc.

PLATE KB18- 08

CONSOLIDATION TEST RESULTS

VOID RATIO vs PRESSURE

ASTM D-2435



MATERIAL DESCRIPTION:		
Shelby Tube		
1AOC-C1 Tank		
Non Firous Peat		
TEST SPECIMEN PROPERTIES	INITIAL	FINAL
Water Content, %	73.65	44.94
Void Ratio	1.9454	1.0258
Saturation, %	99.95	99.98
Sample Height, inches	1.0000	0.6878
Unit Dry Weight, pcf	55.96	81.36
Sample Diameter, inches	2.50	2.50
Liquid Limit, %	51	
Plastic Limit , %	40	
Plasticity Index, %	11	
Specific Gravity	2.64	Assumed

CONSOLIDATION PROPERTIES				
Compression Index			Preconsolidation Stress,tsf	
Recompression Index			Existing Overburden Stress,tsf	
Swell Index				

CONSOLIDATION TEST RESULTS			
Client:	Key Environmental	Project No:	18LS3685.01
Project :	No 1 Land Farm Port Reading , NJ	Date:	43287.2997
Boring:	KB18-08	Perf'd By:	MLB
Sample :	Offset ST-1	Chk'd By:	JBJr.
Depth:	17 to 19 ft		

JLT *Laboratories, Inc.*

PLATE KB18- 08

CALCULATION and DATA SUPPORT SHEET

CALCULATIONS PER ASTM D-2435 Section 12.

Property	units	symbol	INITIAL	symbol	FINAL	Description
Specific Gravity		G	2.64	G	2.64	Assumed Value
Diameter	cm	D	6.35	D	6.35	= Diameter of Ring
Area	cm2	A	31.6692	A	31.6692	Based on Diameter of Ring
Moist Weight of Sample	gr	MTo	125.20	Mtf	100.11	Wet weight before & after test
Dry Weight of Sample	gr	MD (1)	72.10	MD (2)	72.10	See notes (1) and (2) below
Moisture Content	%	wo	73.648	wf	44.940	Computed from 12.2.2 of ASTM
Sample Height	cm	Ho	2.5400	Hf (3)	1.747	= Hf = Ho-Height Change
Volume	cm3	Vo	80.4397	Vf	55.3261	= Area x Height
Dry Density	g/cm3	DDo	0.89632	DDf	1.30318	= Dry weight / Volume (12.2.3)
Dry Density	lbs/cf	gdo	55.9575	gdf	81.3577	= Conversion to pcf (12.2.4)
Volume of Solids	cm3	Vso	27.3106	Vsf	27.3106	Computed from 12.2.5 of ASTM
Height of Solids	cm	Hs	0.8624	Hs	0.86237	Computed from 12.2.6 of ASTM
Void Ratio		Vo	1.94537	Vf	1.02581	Computed from 12.2.7 of ASTM
Degree of Saturation	%	So	99.9	Sf	100.0	Computed from 12.2.8 of ASTM

(1) Dry weight of specimen at the end of the test was used as initial dry weight

(2) Dry weight of specimen at the end of the test

(3) Final height = initial height minus total compression

Initial Dial Reading : 0.0337 Initial Sample Height : 1.0000 inches

Load : Compression Summary See Plate KB18-08			
Load tsf	Final Dial Reading	Compression %	Plot Value %
0.25	0.0421	0.84	-0.84
0.5	0.0561	2.24	-2.24
1	0.0812	4.75	-4.75
2	0.1357	10.20	-10.20
4	0.2322	19.85	-19.85
8	0.3151	28.14	-28.14
16	0.3886	35.49	-35.49
4	0.3730	33.93	-33.93
1	0.3436	30.99	-30.99
0.25	0.3122	27.85	-27.85

Notes:
1. Time/Displacement Plots are listed in Red
2. See Figures : A through E Time/Displacement Data

JLT Laboratories, Inc.

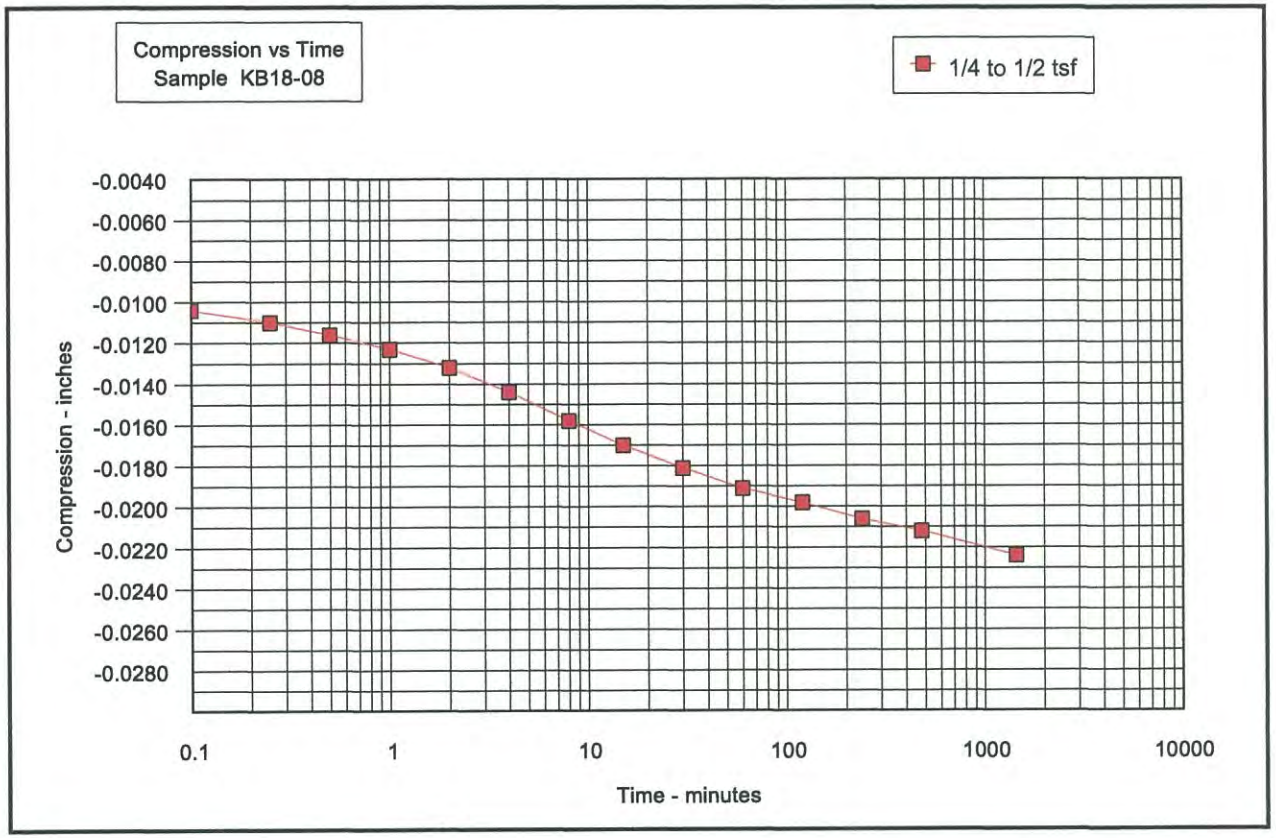
Tube KB18-08 17 to 19
UNIT 1

Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-08 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 1
Initial Dial = 0.0337 Zero Load
Start Dial = 0.0421 This Load

Time min	Dial Reading	Displacement inches
0.00	0.0421	-0.0084
0.10	0.0441	-0.0104
0.25	0.0447	-0.0110
0.50	0.0453	-0.0116
1.00	0.0460	-0.0123
2.00	0.0469	-0.0132
4.00	0.0481	-0.0144
8.00	0.0495	-0.0158
15.00	0.0507	-0.0170
30.00	0.0518	-0.0181
60.00	0.0528	-0.0191
120.00	0.0535	-0.0198
240.00	0.0543	-0.0206
480.00	0.0549	-0.0212
1440.00	0.0561	-0.0224
al Reading =		0.0561
Total Displacement =		-0.0224
Percent Compression =		-2.24%



JLT Laboratories, Inc.

1/4 to 1/2 TSF
FIGURE A

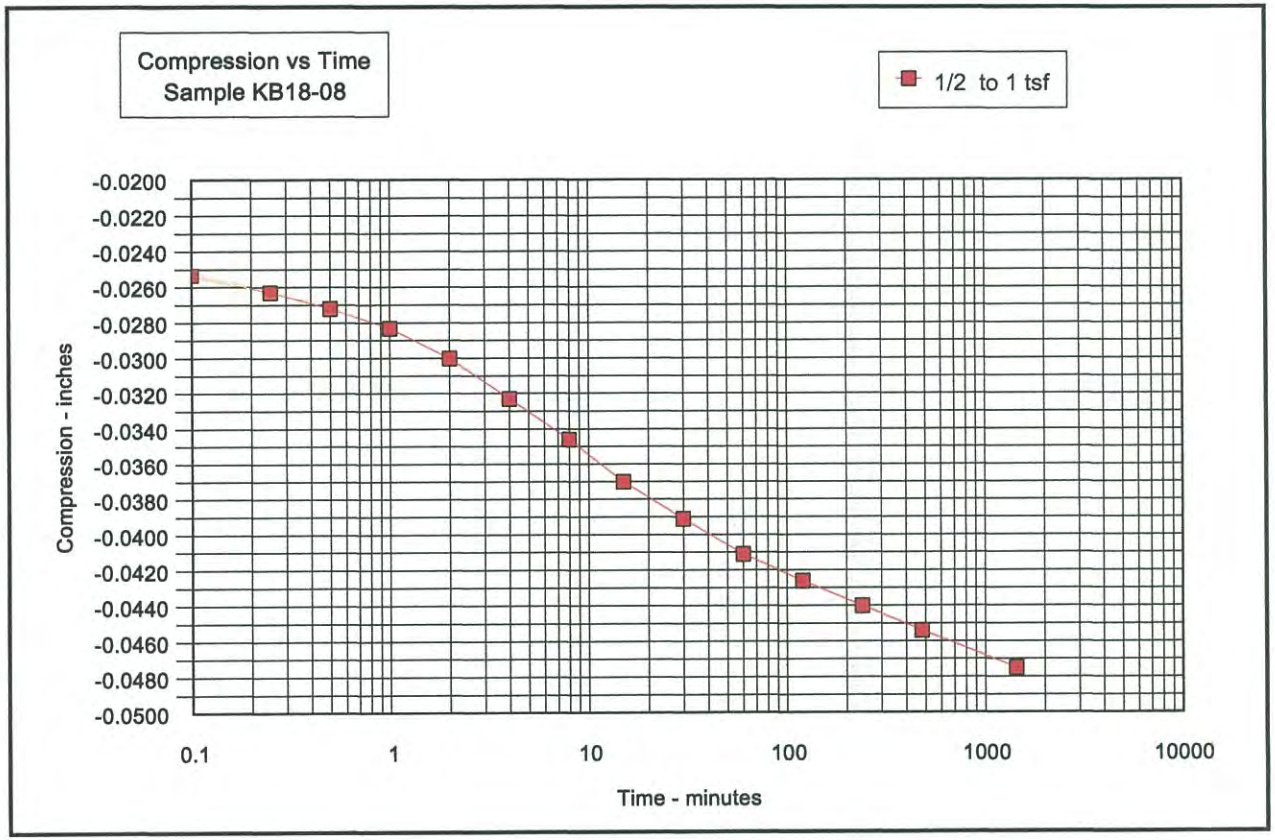
Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-08 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 1
Initial Dial = 0.0337 Zero Load
Start Dial = 0.0561 This Load

Time min	Dial Reading	Displacement inches
0.00	0.0561	-0.0224
0.10	0.0590	-0.0253
0.25	0.0600	-0.0263
0.50	0.0609	-0.0272
1.00	0.0620	-0.0283
2.00	0.0637	-0.0300
4.00	0.0660	-0.0323
8.00	0.0683	-0.0346
15.00	0.0707	-0.0370
30.00	0.0728	-0.0391
60.00	0.0748	-0.0411
120.00	0.0763	-0.0426
240.00	0.0777	-0.0440
480.00	0.0791	-0.0454
1440.00	0.0812	-0.0475

al Reading =	0.0812
splacement =	-0.0475
ompression =	-4.75%



JLT Laboratories, Inc.

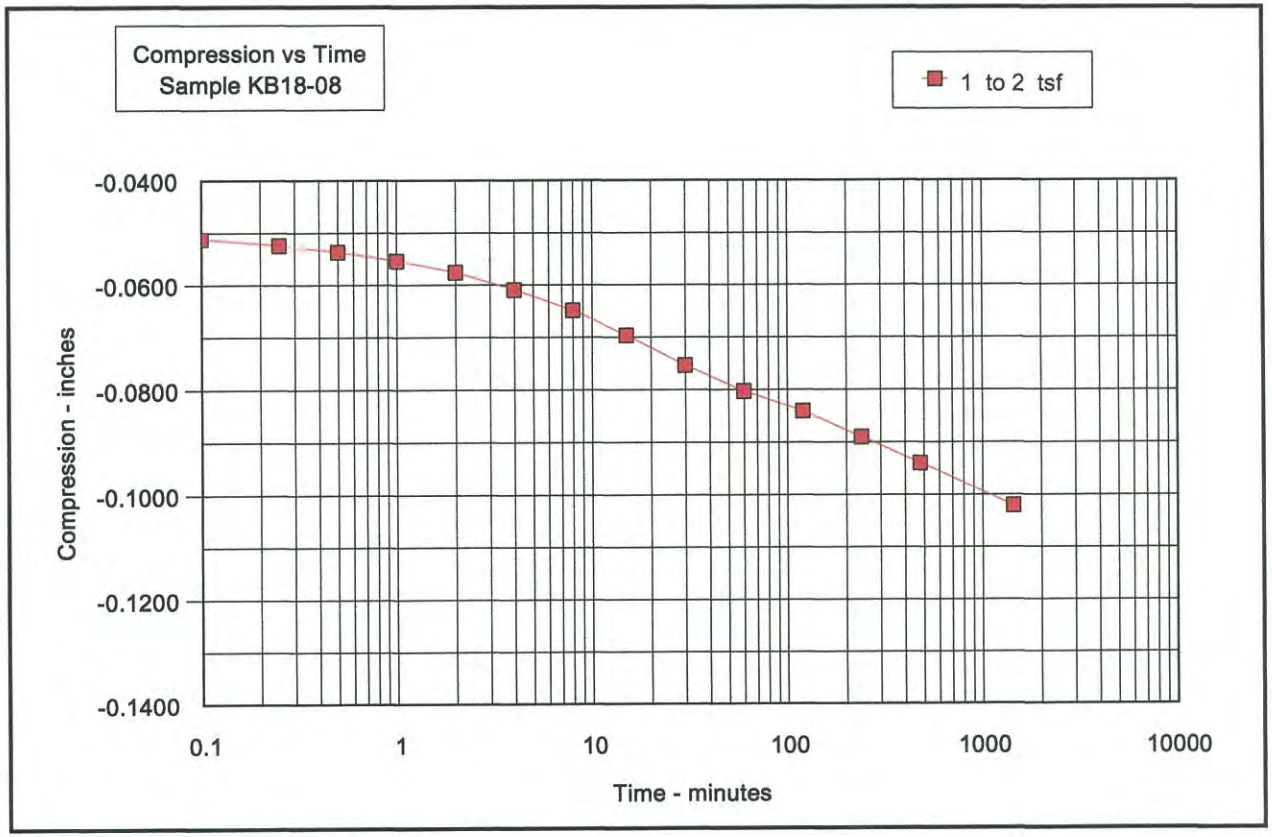
1/2 to 1 TSF
FIGURE B

Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-08 15 to 17

Date: 43282.317
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 1
Initial Dial = 0.0337 Zero Load
Start Dial = 0.0812 This Load

Time min	Dial Reading	Displacement inches
0.00	0.0812	-0.0475
0.10	0.0849	-0.0512
0.25	0.0861	-0.0524
0.50	0.0874	-0.0537
1.00	0.0891	-0.0554
2.00	0.0913	-0.0576
4.00	0.0946	-0.0609
8.00	0.0985	-0.0648
15.00	0.1033	-0.0696
30.00	0.1090	-0.0753
60.00	0.1139	-0.0802
120.00	0.1177	-0.0840
240.00	0.1227	-0.0890
480.00	0.1277	-0.0940
1440.00	0.1357	-0.1020
al Reading =		0.1357
Total Displacement =		-0.1020
Percent Compression =		-10.20%



JLT Laboratories, Inc.

1 to 2 TSF
FIGURE C

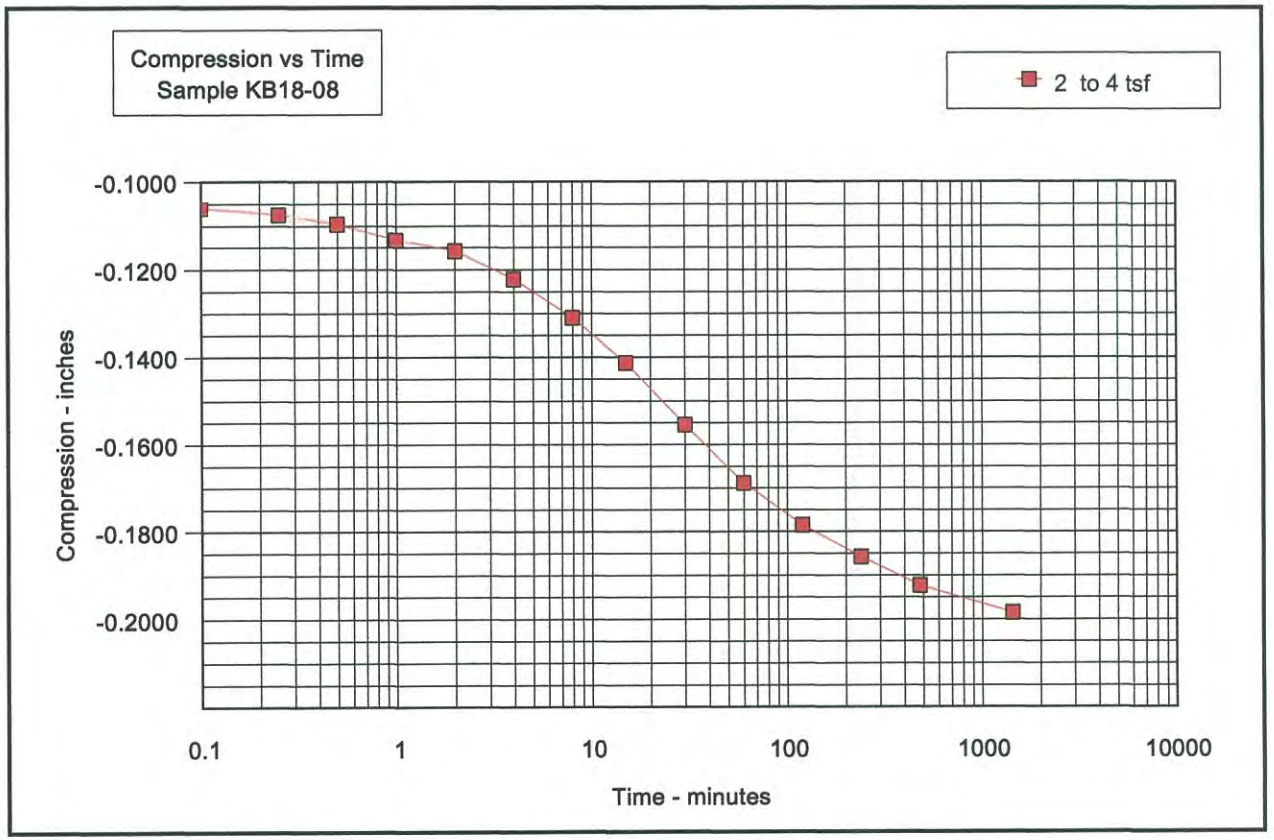
Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-08 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 1
Initial Dial = 0.0337 Zero Load
Start Dial = 0.1357 This Load

Time min	Dial Reading	Displacement inches
0.00	0.1357	-0.1020
0.10	0.1397	-0.1060
0.25	0.1412	-0.1075
0.50	0.1433	-0.1096
1.00	0.1469	-0.1132
2.00	0.1494	-0.1157
4.00	0.1558	-0.1221
8.00	0.1646	-0.1309
15.00	0.1750	-0.1413
30.00	0.1891	-0.1554
60.00	0.2025	-0.1688
120.00	0.2122	-0.1785
240.00	0.2194	-0.1857
480.00	0.2260	-0.1923
1440.00	0.2322	-0.1985

al Reading =	0.2322
Total Displacement =	-0.1985
Percent Compression =	-19.85%



JLT Laboratories, Inc.

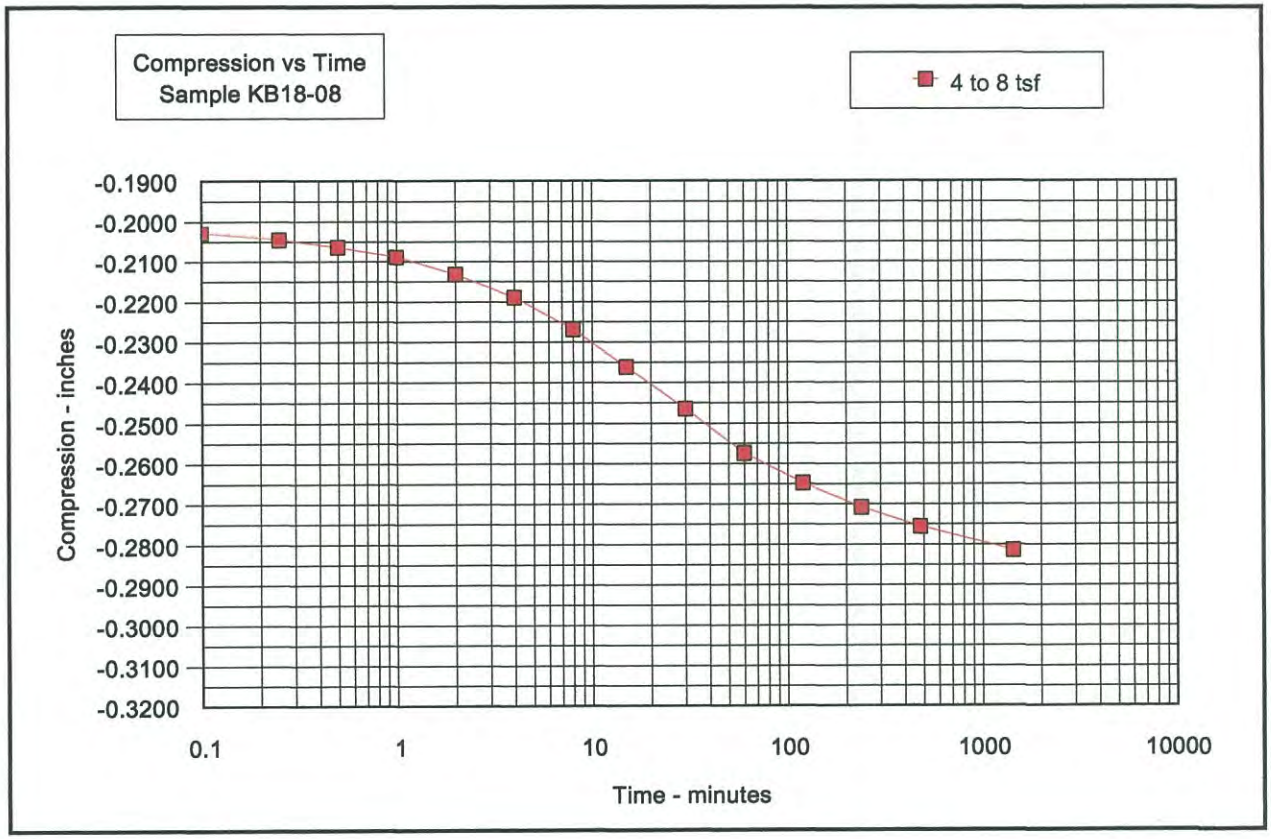
2 to 4 TSF
FIGURE D

Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-08 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 1
Initial Dial = 0.0337 Zero Load
Start Dial = 0.2322 This Load

Time min	Dial Reading	Displacement inches
0.00	0.2322	-0.1985
0.10	0.2365	-0.2028
0.25	0.2382	-0.2045
0.50	0.2401	-0.2064
1.00	0.2425	-0.2088
2.00	0.2469	-0.2132
4.00	0.2526	-0.2189
8.00	0.2605	-0.2268
15.00	0.2698	-0.2361
30.00	0.2801	-0.2464
60.00	0.2911	-0.2574
120.00	0.2984	-0.2647
240.00	0.3045	-0.2708
480.00	0.3092	-0.2755
1440.00	0.3151	-0.2814
al Reading =		0.3151
Total Displacement =		-0.3151
Percent Compression =		-31.51%



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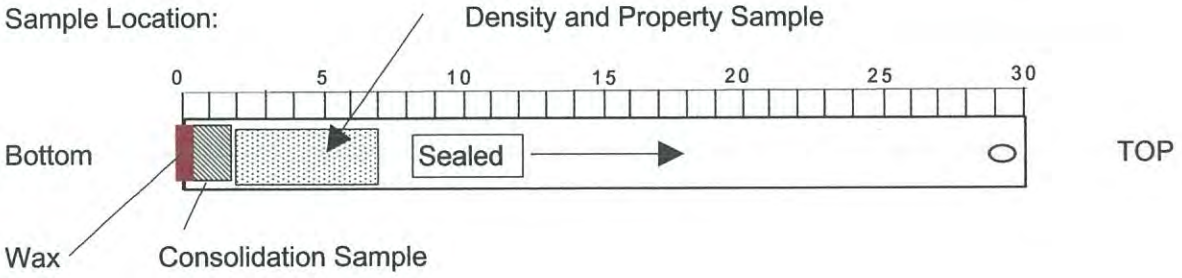
4 to 8 TSF
FIGURE E

DENSITY AND MOISTURE OF TUBE SAMPLES

Client:	Key Environmental	**Job No. :**	18LS3685
Project:	No 1 Land Farm Port Reading , NJ	**Date :**	06/29/2018
Material ID:	Organic Silts	**Perf'd By :**	AE
Tube ID:	Tube KB18-09 Offset ST-1 17 to 19 ft	**Chk'd By :**	JBJr

Sample Location:



Moisture - Density Determination

Tare ID	61		
Section Length :	5.02		inches
Inside Diameter of Sample:	2.85		inches
Wt. of Wet Soil + Tube + Tare	1231.7		grams
Wt. of Dry Soil + Tube + Tare	899.2		grams
Weight of Tube Section only	360.1		grams
Wt. of Tare only	15.9		grams
Weight of Wet Soil only	855.7		grams
Weight of Dry Soil Only	523.2		grams
Weight of Water in Sample	332.5		grams

Moisture Content:	*63.55*	*%*
Bulk Wet Density:	*101.7*	*pcf*
Bulk Dry Density :	*62.7*	*pcf*
Specific Gravity :	*2.72*	

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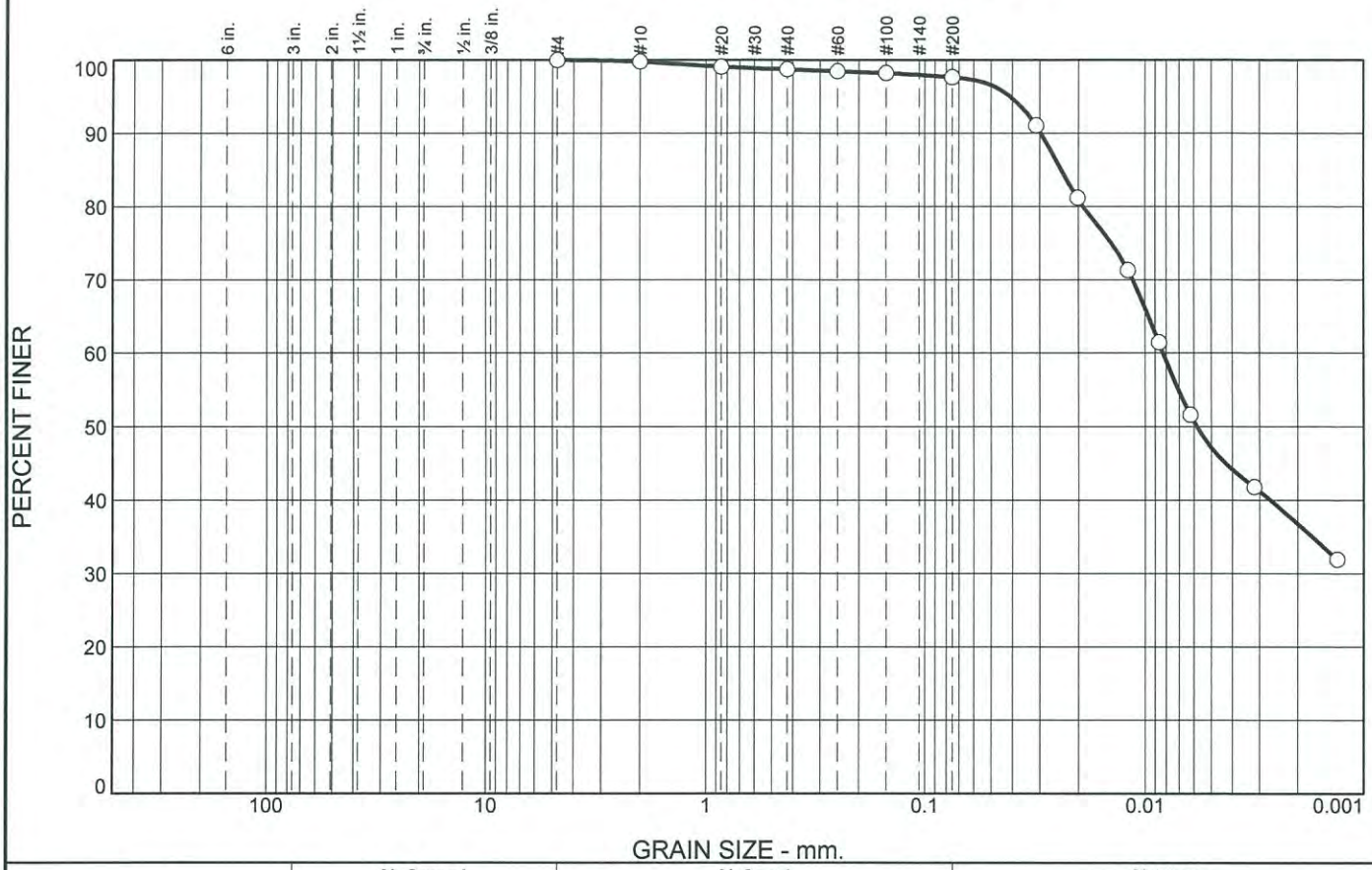
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	1.1	1.0	50.5	47.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.1		
#40	98.7		
#60	98.5		
#100	98.2		
#200	97.7		

* (no specification provided)

Material Description

Off Set
Shelby Tube

Atterberg Limits

PL= 41 LL= 55 PI= 14

Coefficients

D_{90}= 0.0296 D_{85}= 0.0239 D_{60}= 0.0082
D_{50}= 0.0058 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= OH AASHTO=

Remarks

Organic Content = 6.55% / Specific Gravity = 2.72
Visual Classification: High Plastic Organic Silt MH-OH

Location: Port Reading, NJ
Sample Number: KB18-09 ST-1 **Depth:** 17-19 **Date:** 06/29/2018

JLT Laboratories, Inc.

Canonsburg, PA

Client: Key Environmental, Inc.
Project: No. 1 Landfarm, Port Reading, NJ
Key Project No: 18626.01.02
Project No: 18LS3685.01 **Figure**

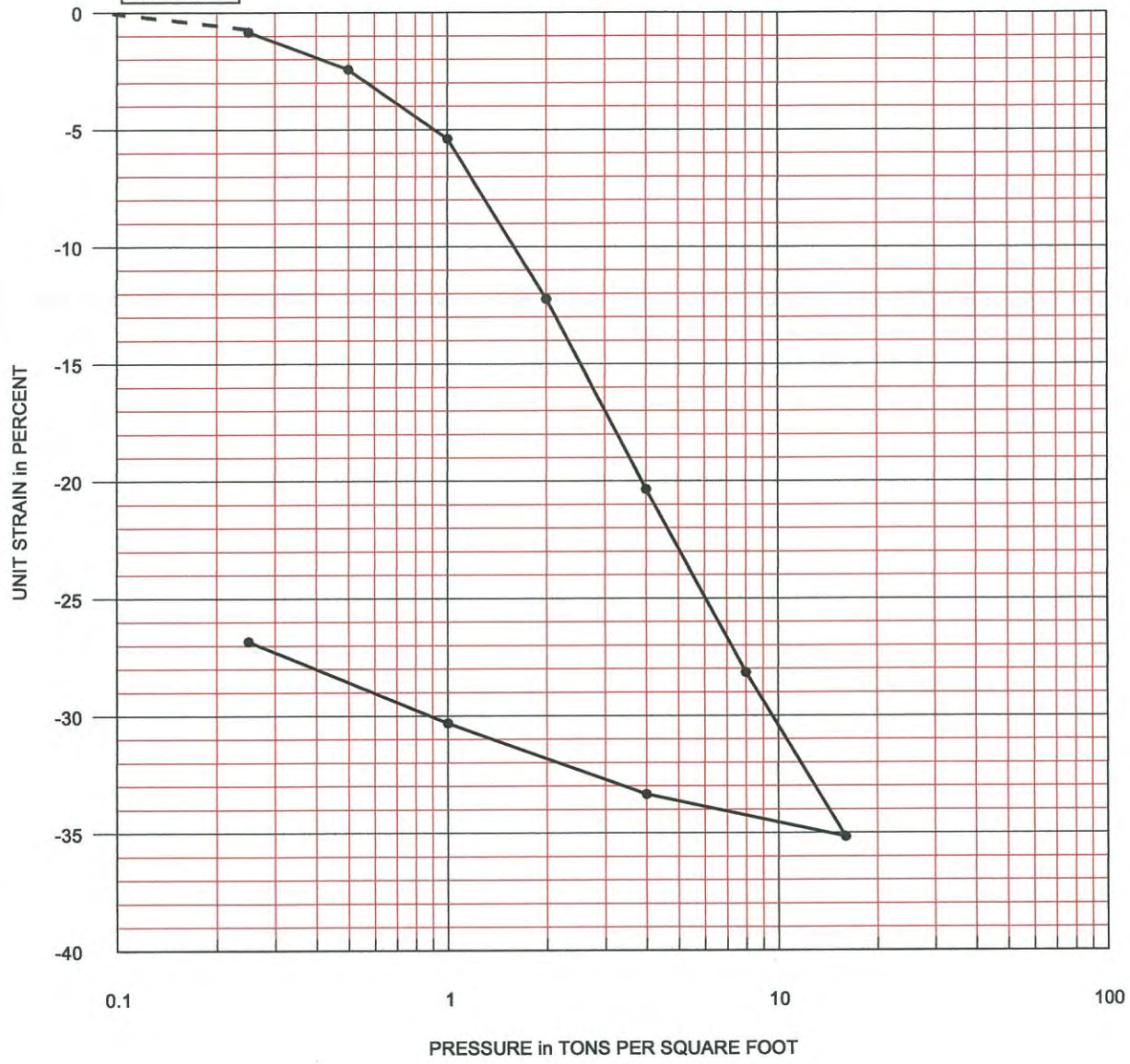
Tested By: AE **Checked By:** JB

CONSOLIDATION TEST RESULTS

STRAIN vs PRESSURE

0 to 1/4 tsf

ASTM D-2435



MATERIAL DESCRIPTION:		
Shelby Tube 1AOC-C1 Tank Non Firous Peat		
TEST SPECIMEN PROPERTIES	INITIAL	FINAL
Water Content, %	70.64	40.47
Void Ratio	1.8736	1.0690
Saturation, %	99.5	100.0
Sample Height, inches	1.0000	0.7200
Unit Dry Weight, pcf	57.35	79.66
Sample Diameter, inches	2.5000	2.5000
Liquid Limit, %	55	
Plastic Limit , %	41	
Plasticity Index, %	14	
Specific Gravity	2.64	Assumed

CONSOLIDATION PROPERTIES				
Compression Index			Preconsolidation Stress,tsf	
Recompression Index			Existing Overburden Stress,tsf	
Swell Index				

CONSOLIDATION TEST RESULTS			
Client:	Key Environmental	Project No:	18LS3685.01
Project :	No 1 Land Farm Port reading , NJ	Print Date :	07/06/2018
Boring:	KB18-09	Perf'd By:	MLB
Sample :	Offset ST-1	Chk'd By:	JBJr.
Depth:	17 to 19 ft		

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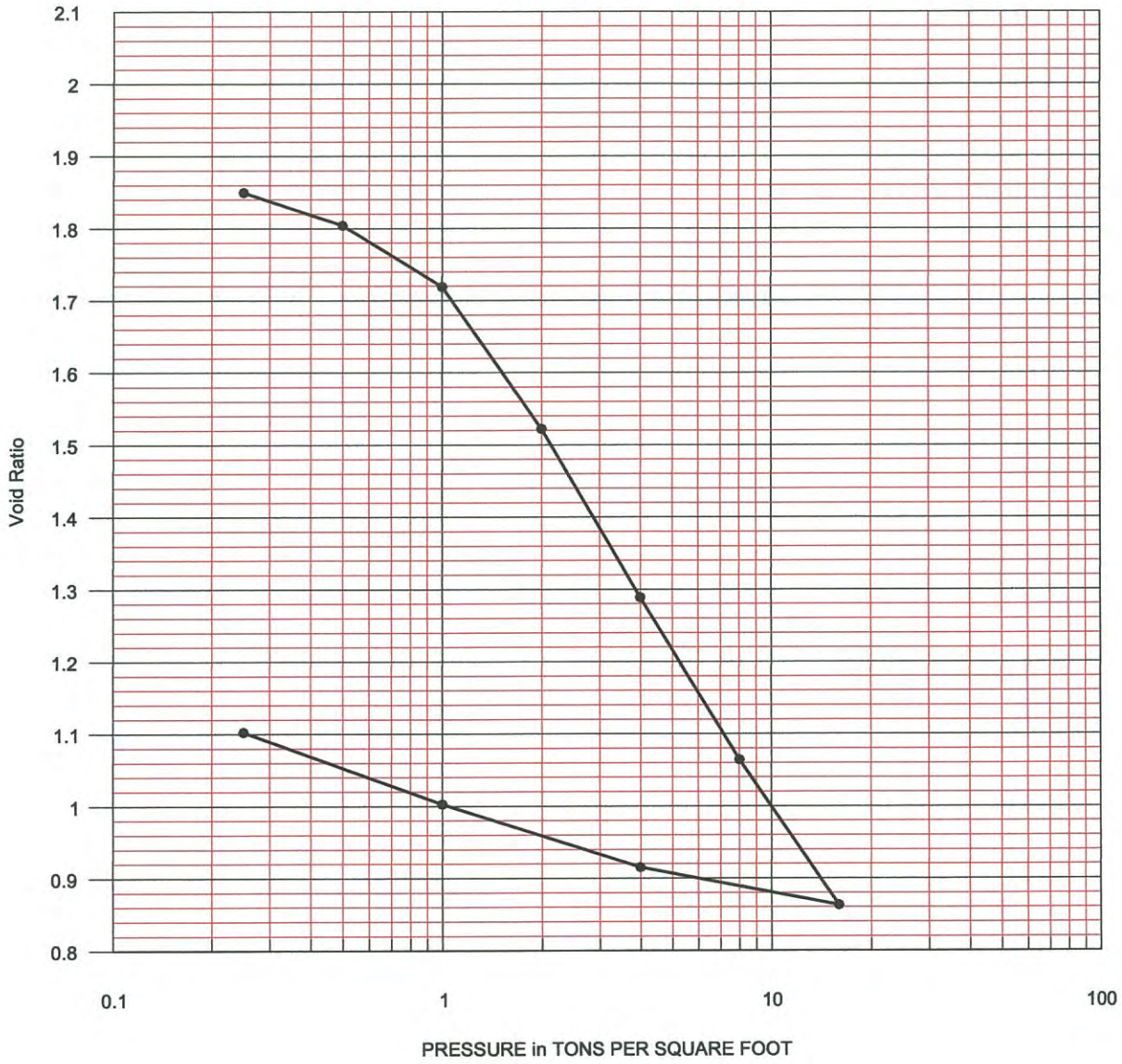
PLATE KB18- 09

CONSOLIDATION TEST RESULTS

VOID RATIO vs PRESSURE

ASTM D-2435



MATERIAL DESCRIPTION:		
Shelby Tube 1AOC-C1 Tank Non Firous Peat		
TEST SPECIMEN PROPERTIES	INITIAL	FINAL
Water Content, %	70.64	40.47
Void Ratio	1.8736	1.0690
Saturation, %	99.53	99.95
Sample Height, inches	1.0000	0.7200
Unit Dry Weight, pcf	57.35	79.66
Sample Diameter, inches	2.50	2.50
Liquid Limit, %	55	
Plastic Limit , %	41	
Plasticity Index, %	14	
Specific Gravity	2.64	Assumed

CONSOLIDATION PROPERTIES				
Compression Index			Preconsolidation Stress,tsf	
Recompression Index			Existing Overburden Stress,tsf	
Swell Index				

CONSOLIDATION TEST RESULTS

Client:	Key Environmental	Project No:	18LS3685.01
Project :	No 1 Land Farm Port reading , NJ	Date:	43287.3109
Boring:	KB18-09	Perf'd By:	MLB
Sample :	Offset ST-1	Chk'd By:	JBJr.
Depth:	17 to 19 ft		

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PLATE KB18- 09

CALCULATION and DATA SUPPORT SHEET

CALCULATIONS PER ASTM D-2435 Section 12.

Property	units	symbol	INITIAL	symbol	FINAL	Description
Specific Gravity		G	2.64	G	2.64	Assumed Value
Diameter	cm	D	6.35	D	6.35	= Diameter of Ring
Area	cm2	A	31.6692	A	31.6692	Based on Diameter of Ring
Moist Weight of Sample	gr	MTo	126.10	Mtf	103.81	Wet weight before & after test
Dry Weight of Sample	gr	MD (1)	73.90	MD (2)	73.90	See notes (1) and (2) below
Moisture Content	%	wo	70.636	wf	40.474	Computed from 12.2.2 of ASTM
Sample Height	cm	Ho	2.5400	Hf (3)	1.8288	= Hf = Ho-Height Change
Volume	cm3	Vo	80.4397	Vf	57.9166	= Area x Height
Dry Density	g/cm3	DDo	0.9187	DDf	1.27597	= Dry weight / Volume (12.2.3)
Dry Density	lbs/cf	gdo	57.3544	gdf	79.659	= Conversion to pcf (12.2.4)
Volume of Solids	cm3	Vso	27.9924	Vsf	27.9924	Computed from 12.2.5 of ASTM
Height of Solids	cm	Hs	0.8839	Hs	0.8839	Computed from 12.2.6 of ASTM
Void Ratio		Vo	1.87363	Vf	1.06901	Computed from 12.2.7 of ASTM
Degree of Saturation	%	So	99.5	Sf	100.0	Computed from 12.2.8 of ASTM

(1) Dry weight of specimen at the end of the test was used as initial dry weight

(2) Dry weight of specimen at the end of the test

(3) Final height = initial height minus total compression

Dial Reading : 0.0117 Sample Height : 1.0000 inches

Load : Compression Summary See Plate KB18-09			
Load tsf	Final Dial Reading	Compression %	Plot Value %
0.25	0.0201	0.84	-0.84
0.5	0.0360	2.43	-2.43
1	0.0656	5.39	-5.39
2	0.1340	12.23	-12.23
4	0.2152	20.35	-20.35
8	0.2933	28.16	-28.16
16	0.3633	35.16	-35.16
4	0.3452	33.35	-33.35
1	0.3148	30.31	-30.31
0.25	0.2800	26.83	-26.83

Notes:
1. Time/Displacement Plots are listed in Red
2. See Figures : A through E Time/Displacement Data

Tube KB18-09 17 to 19
UNIT 2

JLT *Laboratories, Inc.*

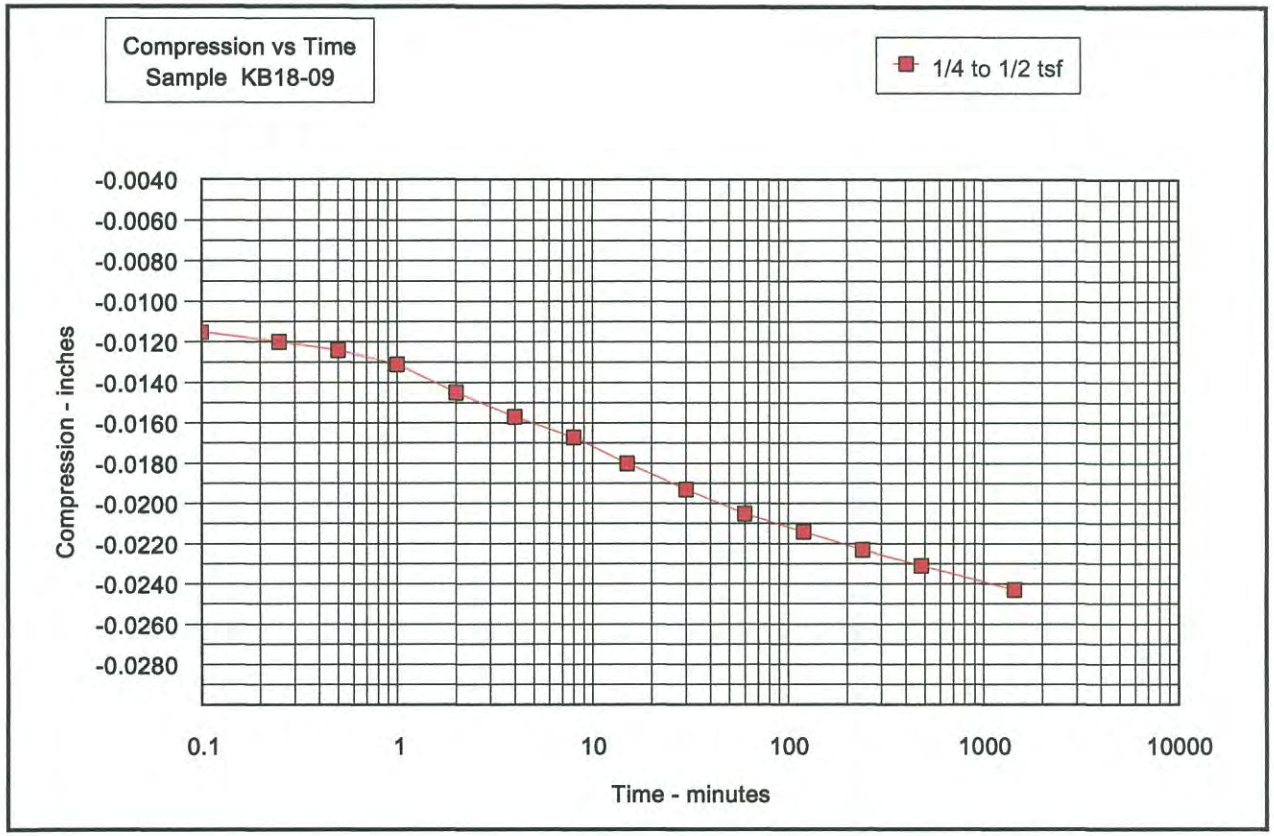
Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-09 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 2
Initial Dial = 0.0117 Zero Load
Start Dial = 0.0201 This Load

Time min	Dial Reading	Displacement inches
0.00	0.0201	-0.0084
0.10	0.0232	-0.0115
0.25	0.0237	-0.0120
0.50	0.0241	-0.0124
1.00	0.0248	-0.0131
2.00	0.0262	-0.0145
4.00	0.0274	-0.0157
8.00	0.0284	-0.0167
15.00	0.0297	-0.0180
30.00	0.0310	-0.0193
60.00	0.0322	-0.0205
120.00	0.0331	-0.0214
240.00	0.0340	-0.0223
480.00	0.0348	-0.0231
1440.00	0.0360	-0.0243

Final Dial Reading =	0.0360
Total Displacement =	-0.0243
Percent Compression =	-2.43%



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1/4 to 1/2 TSF
FIGURE A

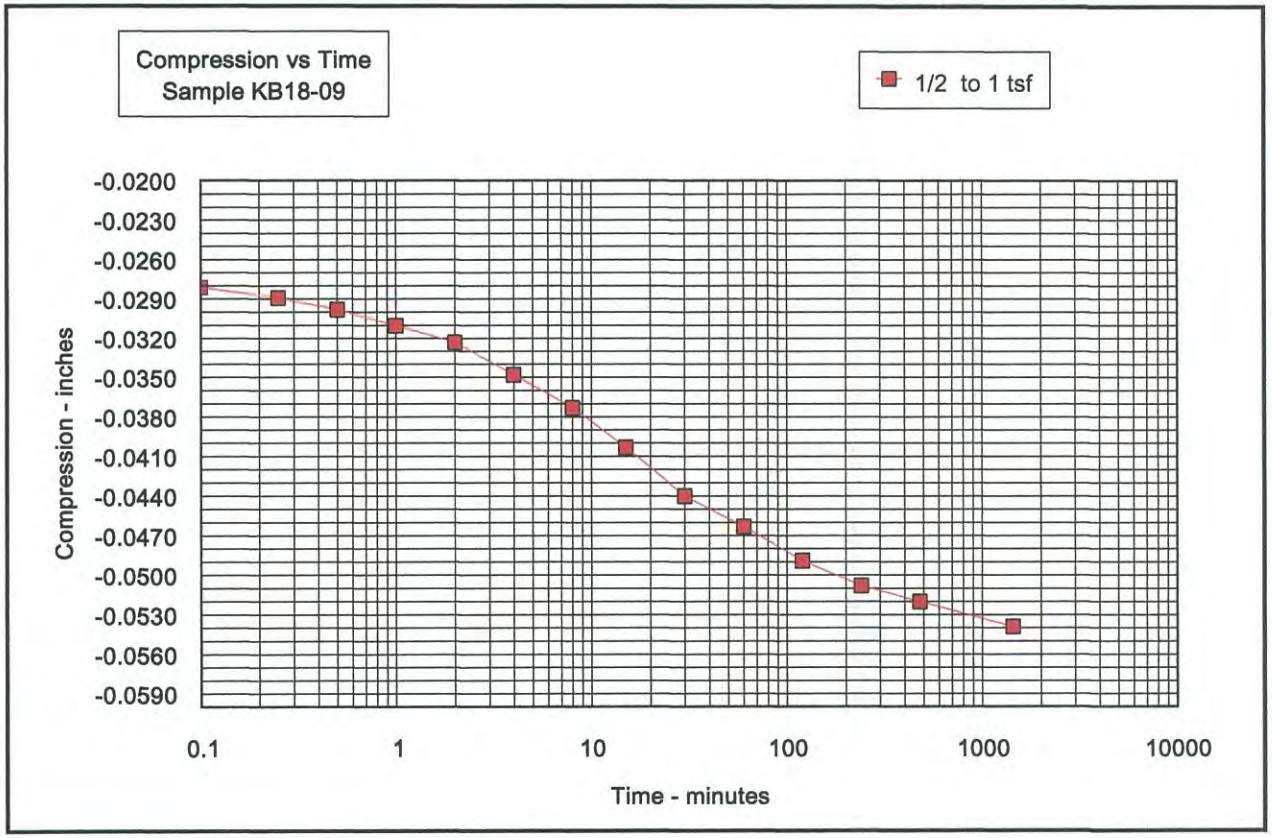
Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-09 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 2
Initial Dial = 0.0117 Zero Load
Start Dial = 0.0360 This Load

Time min	Dial Reading	Displacement inches
0.00	0.0360	-0.0243
0.10	0.0398	-0.0281
0.25	0.0406	-0.0289
0.50	0.0415	-0.0298
1.00	0.0427	-0.0310
2.00	0.0440	-0.0323
4.00	0.0465	-0.0348
8.00	0.0490	-0.0373
15.00	0.0520	-0.0403
30.00	0.0557	-0.0440
60.00	0.0580	-0.0463
120.00	0.0606	-0.0489
240.00	0.0625	-0.0508
480.00	0.0637	-0.0520
1440.00	0.0656	-0.0539

al Reading =	0.0656
Total Displacement =	-0.0539
Percent Compression =	-5.39%



JLT Laboratories, Inc.

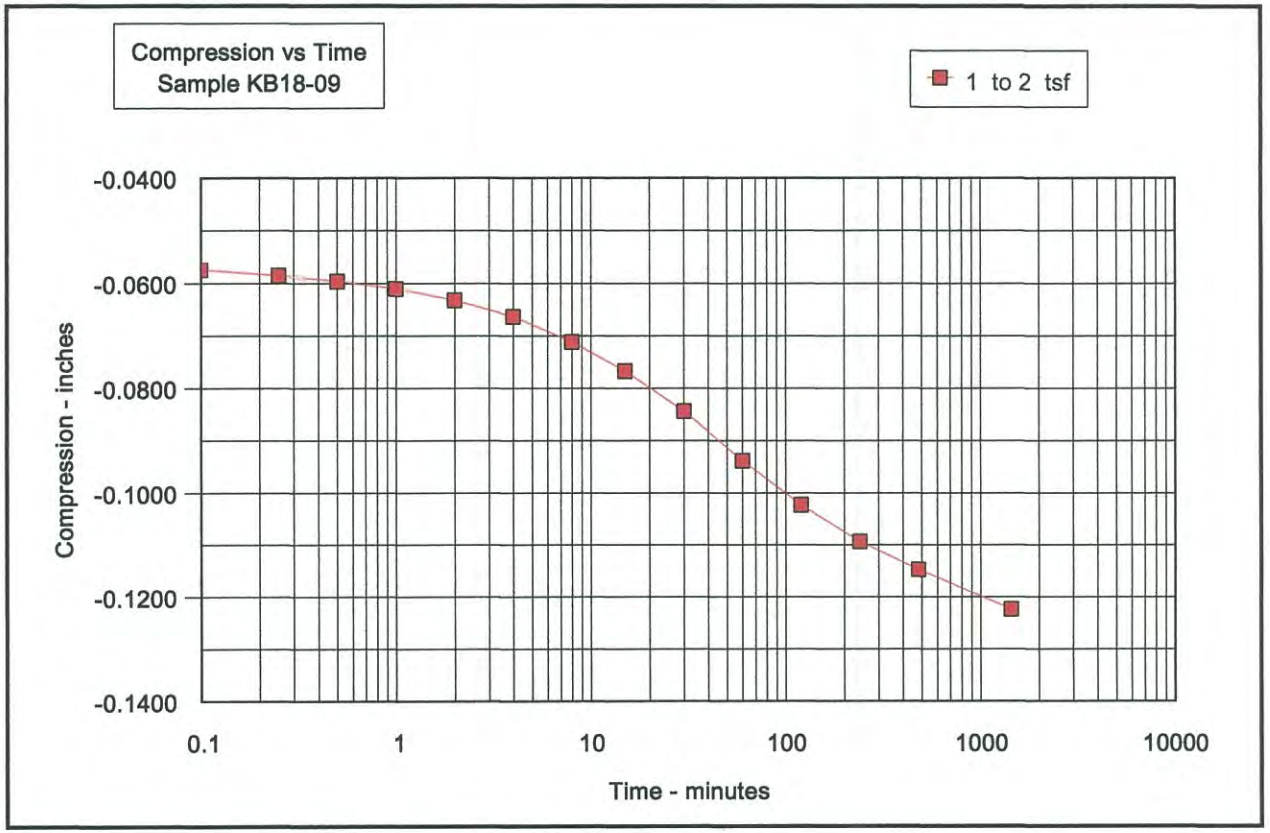
1/2 to 1 TSF
FIGURE B

Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-09 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 2
Initial Dial = 0.0117 Zero Load
Start Dial = 0.0656 This Load

Time min	Dial Reading	Displacement inches
0.00	0.0656	-0.0539
0.10	0.0691	-0.0574
0.25	0.0702	-0.0585
0.50	0.0713	-0.0596
1.00	0.0727	-0.0610
2.00	0.0749	-0.0632
4.00	0.0780	-0.0663
8.00	0.0828	-0.0711
15.00	0.0884	-0.0767
30.00	0.0960	-0.0843
60.00	0.1055	-0.0938
120.00	0.1140	-0.1023
240.00	0.1210	-0.1093
480.00	0.1264	-0.1147
1440.00	0.1340	-0.1223
al Reading =		0.1340
Total Displacement =		-0.1223
Percent Compression =		-12.23%



JLT Laboratories, Inc.

1 to 2 TSF
FIGURE C

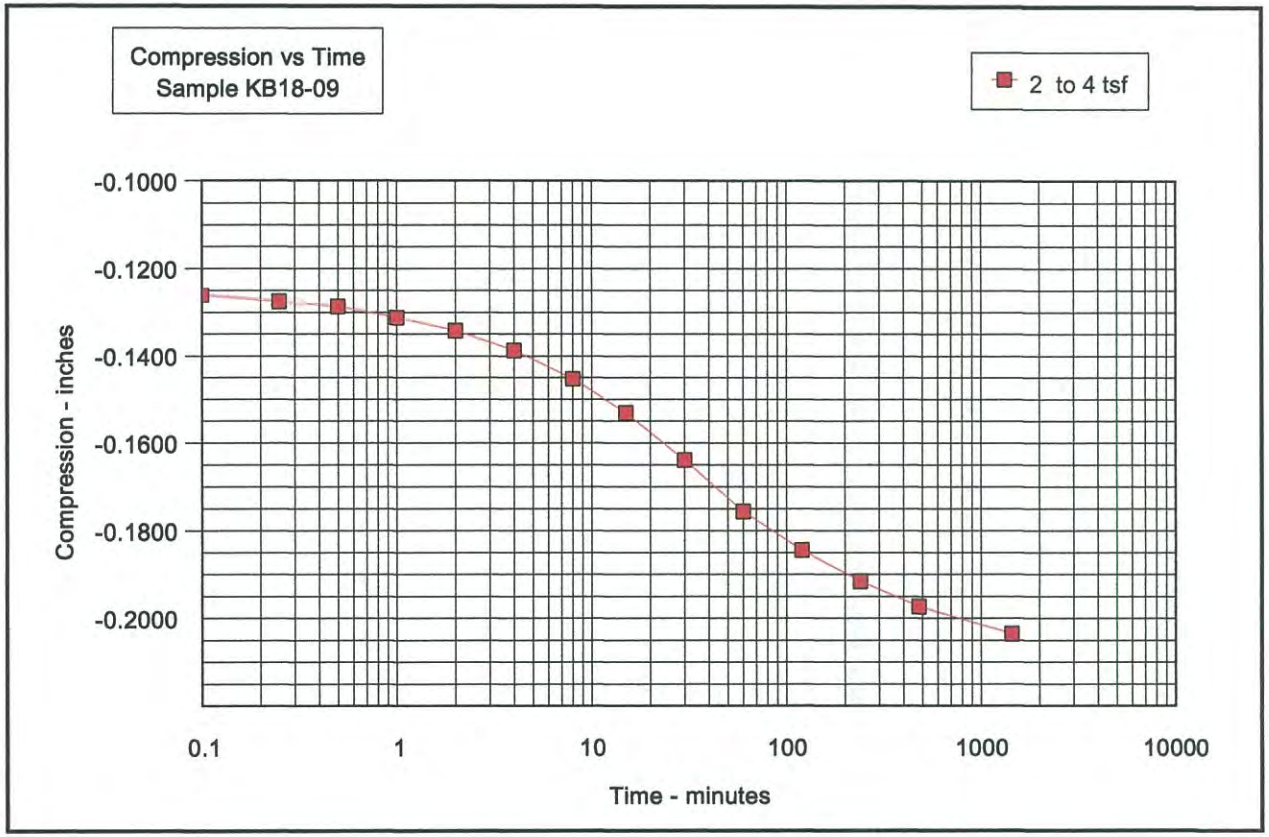
Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-09 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

Unit No.: 2
Initial Dial = 0.0117 Zero Load
Start Dial = 0.1340 This Load

Time min	Dial Reading	Displacement inches
0.00	0.1340	-0.1223
0.10	0.1377	-0.1260
0.25	0.1392	-0.1275
0.50	0.1403	-0.1286
1.00	0.1429	-0.1312
2.00	0.1459	-0.1342
4.00	0.1504	-0.1387
8.00	0.1570	-0.1453
15.00	0.1648	-0.1531
30.00	0.1756	-0.1639
60.00	0.1873	-0.1756
120.00	0.1961	-0.1844
240.00	0.2032	-0.1915
480.00	0.2090	-0.1973
1440.00	0.2152	-0.2035

al Reading =	0.2152
Total Displacement =	-0.2035
Percent Compression =	-20.35%



JLT Laboratories, Inc.

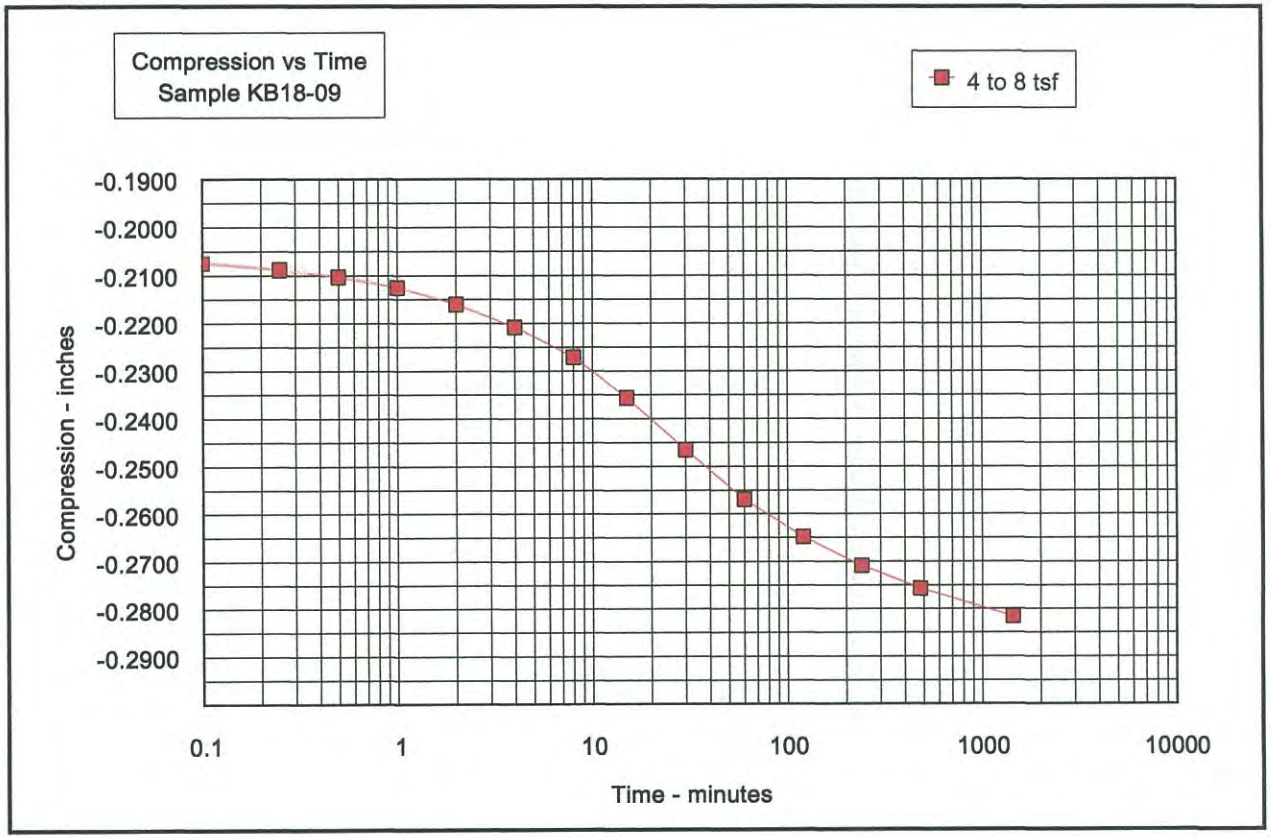
2 to 4 TSF
FIGURE D

Client: Key Environmental
Project: No 1 Land Farm Port Reading
Material Description: KB18-09 15 to 17

Date: 07/01/2018
Job No.: 18LS3665
Perf'd By: MLB
Chk'd By: JBJr.

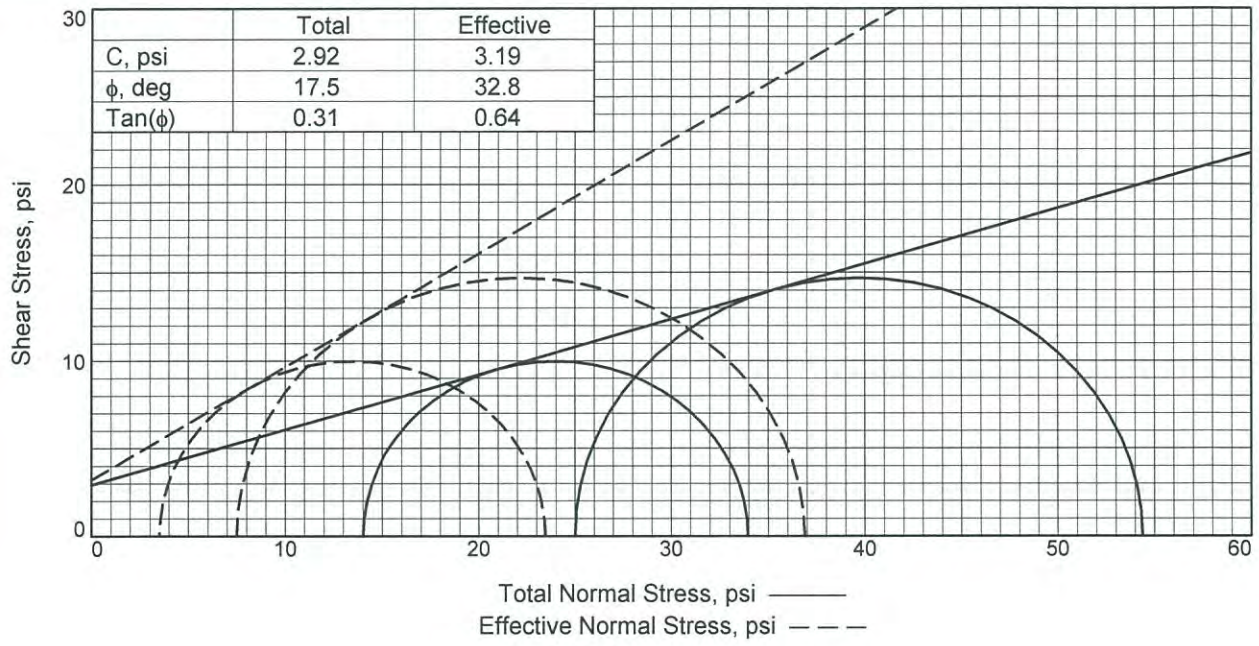
Unit No.: 2
Initial Dial = 0.0117 Zero Load
Start Dial = 0.2152 This Load

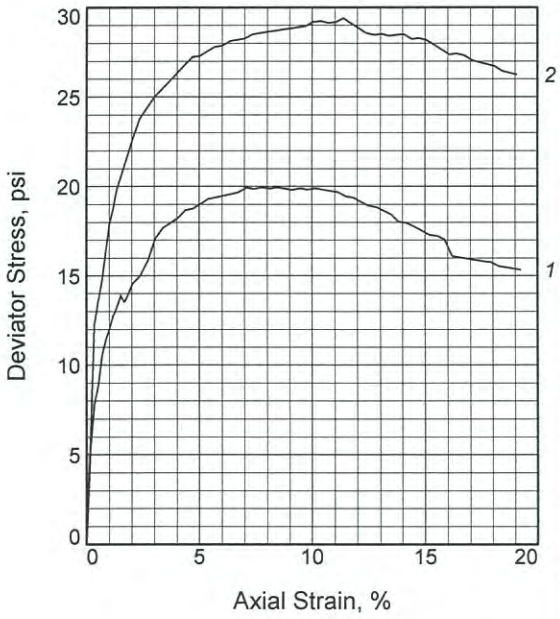
Time min	Dial Reading	Displacement inches
0.00	0.2152	-0.2035
0.10	0.2191	-0.2074
0.25	0.2205	-0.2088
0.50	0.2220	-0.2103
1.00	0.2242	-0.2125
2.00	0.2277	-0.2160
4.00	0.2325	-0.2208
8.00	0.2388	-0.2271
15.00	0.2473	-0.2356
30.00	0.2582	-0.2465
60.00	0.2686	-0.2569
120.00	0.2765	-0.2648
240.00	0.2826	-0.2709
480.00	0.2874	-0.2757
1440.00	0.2933	-0.2816
al Reading =		0.2933
Total Displacement =		-0.2933
Percent Compression =		-29.33%



JLT Laboratories, Inc.

4 to 8 TSF
FIGURE E





Sample No.		1	2
Initial	Water Content,	68.3	65.8
	Dry Density, pcf	59.2	59.9
	Saturation,	100.0	98.2
	Void Ratio	1.8395	1.8033
	Diameter, in.	2.820	2.830
	Height, in.	5.800	5.790
At Test	Water Content,	61.7	55.6
	Dry Density, pcf	63.2	67.3
	Saturation,	100.0	100.0
	Void Ratio	1.6617	1.4955
	Diameter, in.	2.702	2.628
	Height, in.	5.922	5.975
Strain rate, in./min.		0.002	0.002
Eff. Cell Pressure, psi		14.0	25.0
Fail. Stress, psi		20.0	29.4
Total Pore Pr., psi		60.5	67.5
Strain, %		8.4	11.4
Ult. Stress, psi			
Total Pore Pr., psi			
Strain, %			
$\bar{\sigma}_1$ Failure, psi		23.5	36.9
$\bar{\sigma}_3$ Failure, psi		3.5	7.5

Type of Test:
CU with Pore Pressures
Sample Type: Shelby Tube
Description: Off Set
Shelby Tube

Specific Gravity= 2.693
Remarks: 2 Point ASTM D-4767

Figure KB1809.17-19

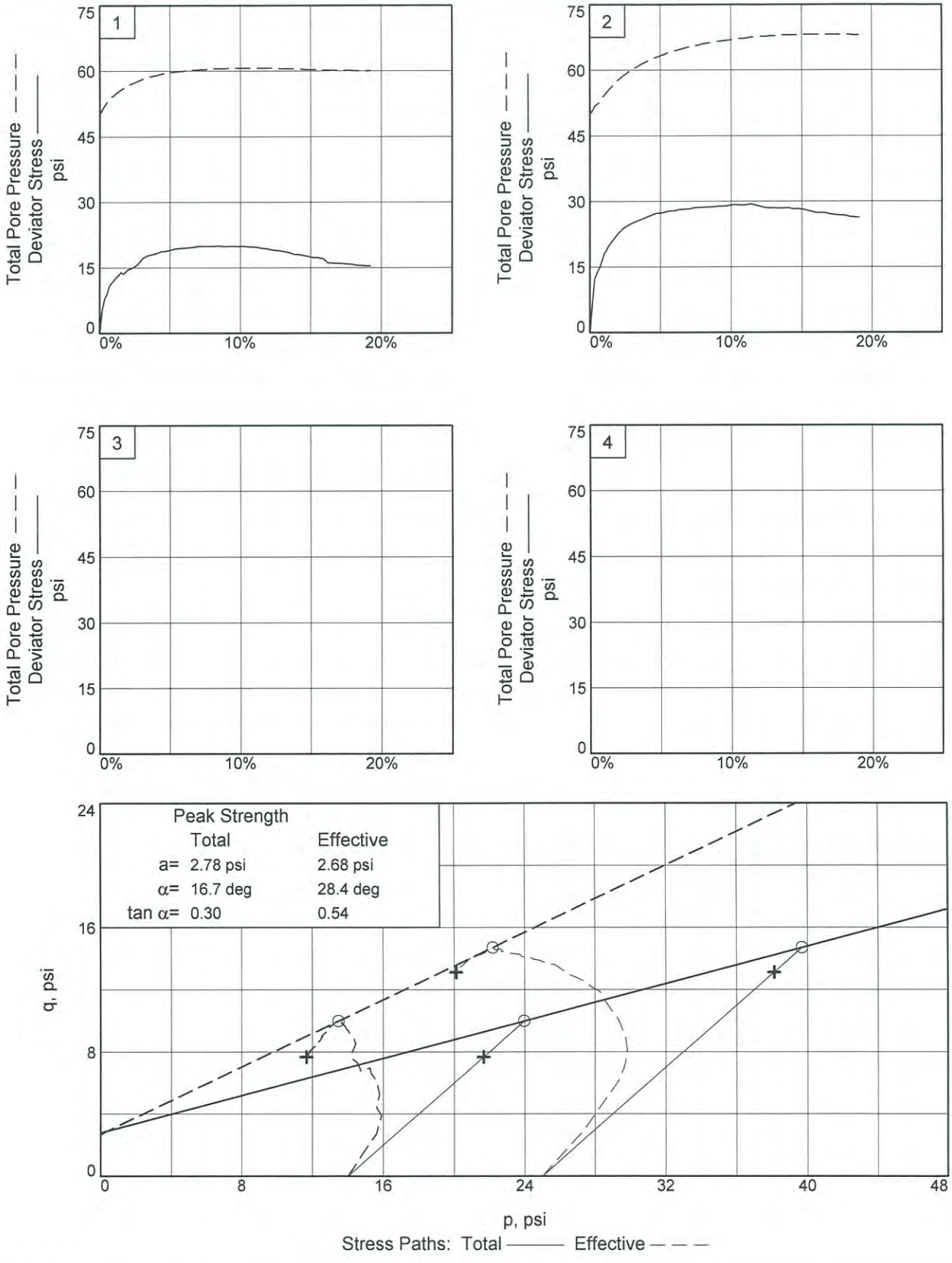
Client: Key Environmental, Inc.

Project: No. 1 Landfarm, Port Reading, NJ
Key Project No: 18626.01.02
Location: Port Reading, NJ
Sample Number: K18-09 ST-1 **Depth:** 17-19
Proj. No.: 18LS3685.01 **Date:** 07/09/2018

TRIAXIAL SHEAR TEST REPORT

JLT Laboratories, Inc.

Tested By: AE **Checked By:** JB



Client: Key Environmental, Inc.
Project: No. 1 Landfarm, Port Reading, NJ
Location: Port Reading, NJ **Depth:** 17-19 **Sample Number:** K18-09 ST-1
Project No.: 18LS3685.01 **Figure** KB1809.17-19

JLT Laboratories, Inc.

Tested By: AE **Checked By:** JB

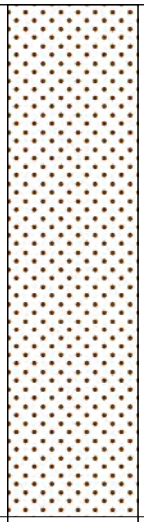
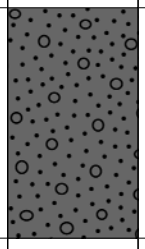
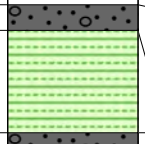
APPENDIX C

Boring Logs

BOREHOLE LOG: KB18-8

DATE DRILLED: 6/8/2018 and 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger and Eugene Blemings
PROJECT NO: 18626-01-02	DRILLING RIG: CME 750 Tractor Rig
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 9.56	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564081.42	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629794.26	TOTAL BORING DEPTH (ft-bgs): 32
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	SP		Reddish Brown (5YR 4/4) MC SAND fill, silty from 0-1 ft-bgs, wet at 3 ft-bgs	Hand Auger 100%	Hand Auger NA	FILL 0-14 ft-bgs
5			No Recovery			
	SP/GP		Black to dark brown FMC silty SAND and GRAVEL (0.125-1.5in.) rounded, wet, no odor	SS-1 (21.6)	6 9 9 5	
			No Recovery			
	SP/GP		Black to dark brown FMC silty SAND and GRAVEL (0.125-1.5in.) rounded, wet, no odor	SS-2 (8.4)	2	
			Black to dark brown silty CLAY		1	
	SW/GW		Black to dark brown C SAND and		9	

NOTES:
Top 6 ft cleared with air knife/hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 7 ft to Northeast of KB18-8 (N564087.74, E629797.91, EL 9.59 ft). Bentonite drilling mud used to keep borehole from collapsing.

BOREHOLE LOG: KB18-8

DATE DRILLED: 6/8/2018 and 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger and Eugene Blemings
PROJECT NO: 18626-01-02	DRILLING RIG: CME 750 Tractor Rig
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 9.56	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564081.42	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629794.26	TOTAL BORING DEPTH (ft-bgs): 32
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
			GRAVEL, (0.25-1.0in.) rounded, some brick fragments		11	
10			No Recovery			
	SW/GW		Black to dark brown C SAND and GRAVEL, (0.25-1.0in.) rounded, black silt layer 10.4-10.7 ft-bgs, brick fragments, wet, no odor	SS-3 (20.4)	3	
					9	
					12	
			No Recovery		8	
	SW		Dark grayish brown MC SAND, wet, no odor	SS-4 (18)	6	
	SW/GW		Black to dark brown MC SAND and GRAVEL, brick fragments, organic odor		5	
					7	
			No Recovery		6	Top of PEAT 14 ft-bgs
15	Pt		Silty PEAT, abundant organics less abundant with depth, trace shell fragments 16-17 ft-bgs, wet, organic odor	SS-5 (24)	1	
					1	Acker 2" Vane and 12" Lower Force Arm ASTM D2573 Vane shear Test at 15 ft-bgs Peak: ≥ 600 in-lbs, ≥ 3102 psf Remolded: 450 in-lbs, 2327 psf
					1	
				SS-6 (12)	WH	
					2	Vane Shear Test 17 ft-bgs Peak: 425 in-lbs, 2197 psf Remolded: 150 in-lbs, 776 psf
			No Recovery		2	
					1	Shelby Tube Sample (ST1) 17-19 ft-bgs Recovery 2/2 ft.
					WH	

NOTES:

Top 6 ft cleared with air knife/hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 7 ft to Northeast of KB18-8 (N564087.74, E629797.91, EL 9.59 ft). Bentonite drilling mud used to keep borehole from collapsing.

BOREHOLE LOG: KB18-8

DATE DRILLED: 6/8/2018 and 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger and Eugene Blemings
PROJECT NO: 18626-01-02	DRILLING RIG: CME 750 Tractor Rig
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 9.56	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564081.42	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629794.26	TOTAL BORING DEPTH (ft-bgs): 32
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
20	Pt		Very dark gray silty clayey PEAT, trace organics and shell fragments, abundant organics 18-18.5 and 20.0-20.2 ft-bgs, wet, organic odor	SS-7 (24)	1	
					1	
					1	
				SS-8 (16.2)	WH	
					WH	
					WH	
					2	
				SS-9 (24)	2	
					1	
					2	
					1	
	SM		Very dark gray MC sandy SILT			Top of SAND 24 ft-bgs
25	SM		Very dark gray MC SAND and SILT, some gravel (0.25-0.5in.) rounded, mottled abundant organics 24.2-24.4 ft-bgs, wet	SS-10 (24)	WH	
					WH	
					WH	
					2	
				SS-11 (17.4)	WH	
	SP		Reddish brown (5YR 4/2) FMC SAND, brick fragments, wet, no odor		WH	
			No Recovery		2	

NOTES:
Top 6 ft cleared with air knife/hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 7 ft to Northeast of KB18-8 (N564087.74, E629797.91, EL 9.59 ft). Bentonite drilling mud used to keep borehole from collapsing.

BOREHOLE LOG: KB18-8

DATE DRILLED: 6/8/2018 and 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger and Eugene Blemings
PROJECT NO: 18626-01-02	DRILLING RIG: CME 750 Tractor Rig
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 9.56	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564081.42	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629794.26	TOTAL BORING DEPTH (ft-bgs): 32
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
	SM		Very dark gray silty MC SAND, mottled, wet, faint odor	SS-12 (20.4)	2 3 6	
	SP		Reddish brown (5YR 4/2) MVC SAND, wet, no odor		9	
30			No Recovery			
	SP/GW		Reddish brown (5YR 4/2) MVC SAND and GRAVEL, (0.25-0.5in.) rounded, trace silt, abundant brick fragments, wet, no odor	SS-13 (18)	6 13 18	
			No Recovery		21	End of Boring - 32 ft-bgs

NOTES:
Top 6 ft cleared with air knife/hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 7 ft to Northeast of KB18-8 (N564087.74, E629797.91, EL 9.59 ft). Bentonite drilling mud used to keep borehole from collapsing.

BOREHOLE LOG: KB18-9

DATE DRILLED: 6/13/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Jay Blemings
PROJECT NO: 18626-01-02	DRILLING RIG: CME 750 Tractor Rig
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 10.57	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564002.82	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629529.96	TOTAL BORING DEPTH (ft-bgs): 30
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	SW/GP		Very dark grayish brown to brown (10YR 3/2 to 5YR 4/4) silty CVC SAND and GRAVEL (1-1.5 in.) rounded, wet at 3 ft-bgs	Hand Auger 100%	Hand Auger	FILL 0-14 ft-bgs
5			No Recovery	SS-1 (8.4)	1 WH 1 WH	
	SP/GP		Black to Reddish Brown MC SAND and GRAVEL (0.5-1 in.) subangular to rounded, wet, no odor	SS-2 (24)	4 14 15	

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southeast of KB18-9 (N564004.91, E629525.20, EL 11.03 ft).

BOREHOLE LOG: KB18-9

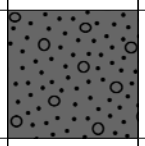
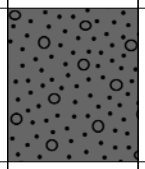
DATE DRILLED: 6/13/2018

PROJECT INFORMATION

PROJECT: Buckeye/Hess Terminal Land Farm No.1
SITE LOCATION: Port Reading, NJ
PROJECT NO: 18626-01-02
KEY FIELD GEOLOGIST: Tracey Smith
GROUND SURFACE ELEVATION (ft): 10.57
NORTHING (ft): 564002.82
EASTING (ft): 629529.96
DATUM: NJSPCS NAD83, NAVD88

DRILLING INFORMATION

DRILLING CO: Unitech Drilling
DRILLER: Jay Blemings
DRILLING RIG: CME 750 Tractor Rig
DRILLING METHOD: HSA (3.25" ID)
SAMPLING METHOD: ASTMD D1586 SPT 2 in.
HAMMER TYPE: 140 lb. Auto Trip (30")
TOTAL BORING DEPTH (ft-bgs): 30
WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
			No Recovery		12	
10	SP/GP		Dark grayish to reddish brown (5Y 3/2 to 5YR 4/2) MC SAND and GRAVEL, (0.5-1.5in.) rounded, some brick fragments, wet, no odor	SS-3 (12)	5	
					6	
			No Recovery		9	
					8	
	SP/GP		Dark grayish brown (5Y 3/2) MC SAND and GRAVEL (0.25-1.5in) subangular to rounded, some brick fragments, wet, no odor	SS-4 (14.4)	9	
					9	
			No Recovery		8	
					8	Top of PEAT 14 ft-bgs
	Pt		Dark grayish brown (5Y 3/2) silty clayey PEAT, abundant organics at top and less with depth, organic odor	SS-5 (16.8)	1	
15					1	Acker 2" Vane and 12" Lower Force Arm ASTM D2573 Vane Shear Test 15 ft-bgs Peak: 525 in-lbs, 2714 psf Remolded: 175 in-lbs, 905 psf
					2	
			No Recovery		2	
				SS-6 (0.0)	2	
					1	Vane Shear Test 17 Peak: 500 in-lbs, 2585 psf Remolded: 275 in-lbs, 1422 psf
					1	
					1	Shelby Tube Sample (ST1) from 17-19 ft-bgs
					2	

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southeast of KB18-9 (N564004.91, E629525.20, EL 11.03 ft).

BOREHOLE LOG: KB18-9

DATE DRILLED: 6/13/2018

PROJECT INFORMATION

PROJECT: Buckeye/Hess Terminal Land Farm No.1
SITE LOCATION: Port Reading, NJ
PROJECT NO: 18626-01-02
KEY FIELD GEOLOGIST: Tracey Smith
GROUND SURFACE ELEVATION (ft): 10.57
NORTHING (ft): 564002.82
EASTING (ft): 629529.96
DATUM: NJSPCS NAD83, NAVD88

DRILLING INFORMATION

DRILLING CO: Unitech Drilling
DRILLER: Jay Blemings
DRILLING RIG: CME 750 Tractor Rig
DRILLING METHOD: HSA (3.25" ID)
SAMPLING METHOD: ASTMD D1586 SPT 2 in.
HAMMER TYPE: 140 lb. Auto Trip (30")
TOTAL BORING DEPTH (ft-bgs): 30
WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
	Pt		Dark grayish brown (5Y 3/2) silty clayey PEAT, abundant organics, organic odor	SS-7 (24)	2 2 2	
			No Recovery			
20	Pt		Dark grayish brown (5Y 3/2) silty clayey PEAT, abundant organics decreases content with depth, trace shell fragments and F sand, wet, organic odor	SS-8 (24)	1 2 2 2	
	SM		Dark gray silty M SAND, wet	SS-9 (12)	1 2	Top of SAND 22.8 ft-bgs
			No Recovery		2 3	
	SM		Dark gray silty M SAND, little brick fragments and gravel (0.25-0.50in.) rounded, wet	SS-10 (7.20)	1 2	
25			No Recovery		4 5	
	SM/GP		Dark gray silty FVC SAND and GRAVEL (0.50-0.75in.), VC grain size 26.9-27.2 ft-bgs, FM 27.6-28 ft-bgs, wet, no odor	SS-11 (24)	2 4 4 4	

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southeast of KB18-9 (N564004.91, E629525.20, EL 11.03 ft).

BOREHOLE LOG: KB18-9

DATE DRILLED: 6/13/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Jay Blemings
PROJECT NO: 18626-01-02	DRILLING RIG: CME 750 Tractor Rig
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 10.57	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564002.82	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629529.96	TOTAL BORING DEPTH (ft-bgs): 30
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
	SP		Dark grayish brown FMC SAND, grain size increase with depth, some to little brick fragments, trace silt, wet, no odor	SS-12 (19.2)	2 6 8	
30			No Recovery		13	End of Boring - 30 ft-bgs

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southeast of KB18-9 (N564004.91, E629525.20, EL 11.03 ft).

BOREHOLE LOG: KB18-10

DATE DRILLED: 6/5/2018 and 6/7/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger/Mike Shepherd
PROJECT NO: 18626-01-02	DRILLING RIG: CME 55 LC
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 11.00	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564200.00	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629439.24	TOTAL BORING DEPTH (ft-bgs): 28
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3.5

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	SW/GP		Very dark grayish brown silty SAND and GRAVEL fill	Hand Auger 100%	Hand Auger	FILL 0-14 ft-bgs
	SP		Reddish Brown (5YR 4/4) C SAND and GRAVEL, (1-1.5in.) rounded, moist to wet			
5			No Recovery			
	SP		Dark brown (7.5YR 3/2) C SAND, some to little silt, wet	SS-1 (6.6)	2	
			No Recovery		1 1 10	
	SP		Dark brown (7.5YR 3/2) C SAND, some to little silt, wet	SS-2 (4.8)	8	
			No Recovery		18 28	

NOTES:
Top 6 ft of boring was cleared with air knife and hand auger. Bentonite drilling mud used during drilling to keep borehole from collapsing. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southwest of KB18-10 (no coordinates available).

KEY ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: KB18-10

DATE DRILLED: 6/5/2018 and 6/7/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger/Mike Shepherd
PROJECT NO: 18626-01-02	DRILLING RIG: CME 55 LC
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 11.00	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564200.00	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629439.24	TOTAL BORING DEPTH (ft-bgs): 28
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3.5

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
					21	
10	SP		Dark brown (7.5YR 3/2) C SAND, some to little silt, wet	SS-3 (12)	6	
					4	
			No Recovery		3	
					2	
	SM/SP		Dark brown to black (7.5YR 3/2) silty MVC SAND, 1 in. layered lens of silt at 13 ft-bgs, wet, organic odor	SS-4 (12)	2	
					1	
			No Recovery		1	
					1	Top of PEAT 14 ft-bgs
15				SS-5 (24)	1	Acker 3 5/8" Vane and 12" Lower Force Arm ASTM D2573 Vane Shear Test 14 ft-bgs Peak: ≥ 600 in-lbs, ≥ 543 psf Remolded: 400 in-lbs, 362 psf
					2	
					2	
					2	
				SS-6 (24)	1	Vane Shear Test 16.5 ft-bgs Peak: ≥ 600 in-lbs, ≥ 543 psf Remolded: 500 in-lbs, 453 psf Shelby Tube Sample (ST1) from 17-19 ft-bgs Recovery 0.6/2 ft.
					2	
					1	
	Pt		Dark brown to black (7.5Y 3/3) silty clayey PEAT, abundant organics from 14-15.1 ft-bgs, some to little organics 15.1-16 ft-bgs, below 16-22.2 ft-bgs trace organics and shell fragments, wet,		2	
					WH	

NOTES:
Top 6 ft of boring was cleared with air knife and hand auger. Bentonite drilling mud used during drilling to keep borehole from collapsing. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southwest of KB18-10 (no coordinates available).

KEY ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: KB18-10

DATE DRILLED: 6/5/2018 and 6/7/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger/Mike Shepherd
PROJECT NO: 18626-01-02	DRILLING RIG: CME 55 LC
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 11.00	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564200.00	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629439.24	TOTAL BORING DEPTH (ft-bgs): 28
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 3.5

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
			organic odor	SS-7 (24)	WH	
					2	Shelby Tube Sample (ST2) from 19-20 ft-bgs
20					2	Recovery 0.7/2 ft.
				SS-8 (9.6)	2	
					2	
					1	
					1	
	SM/GP		Dark brown (7.5YR 3/2) silty SAND and GRAVEL, wet, organic odor	SS-9 (6)	4	
			No Recovery		5	
					5	
					5	
	Pt		Dark brown to black (7.5YR 3/2) silty clayey PEAT, abundant organics 24-24.9 ft-bgs, little organcis and trace shell fragments 24.9-25.5 ft-bgs, wet, organic odor	SS-10 (24)	2	
25					4	
					4	Top of SAND 25.5 ft-bgs
	SP/GP		Dark brown (5YR 3/3) MC SAND and GRAVEL, (0.5-0.75in.) rounded, wet, no odor		7	
				SS-11 (24)	10	
					5	
					7	
					12	End of Boring - 28 ft-bgs

NOTES:
Top 6 ft of boring was cleared with air knife and hand auger. Bentonite drilling mud used during drilling to keep borehole from collapsing. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Southwest of KB18-10 (no coordinates available).

BOREHOLE LOG: KB18-11

DATE DRILLED: 6/7-6/8/2018

PROJECT INFORMATION

PROJECT: Buckeye/Hess Terminal Land Farm No.1
SITE LOCATION: Port Reading, NJ
PROJECT NO: 18626-01-02
KEY FIELD GEOLOGIST: Tracey Smith
GROUND SURFACE ELEVATION (ft): 9.71
NORTHING (ft): 564362.74
EASTING (ft): 629674.29
DATUM: NJSPCS NAD83, NAVD88

DRILLING INFORMATION

DRILLING CO: Unitech Drilling
DRILLER: Butch Hitzelberger/Mike Shepherd
DRILLING RIG: CME 55 LC and CME 750
DRILLING METHOD: HSA (3.25" ID)
SAMPLING METHOD: ASTMD D1586 SPT 2 in.
HAMMER TYPE: 140 lb. Auto Trip (30")
TOTAL BORING DEPTH (ft-bgs): 30
WATER LEVEL DURING DRILLING (ft-bgs): 2

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	SP		Very dark grayish brown to brown (10YR 4/3 and 5YR 3/3) silty FC SAND, some subangular gravel, wet at 2-4.6 ft-bgs wet, trace chunks of light orange clay	Hand Auger 100%	Hand Auger	FILL 0-13.1 ft-bgs
5			No Recovery			
	SM		Dark brown (7YR 3/2) F sandy SILT, wet	SS-1 (10.8)	WH	
					WH	
			No Recovery		2	
					2	
	SM		Dark brown (7YR 3/2) to black SILT, 1/8 in. thick layers/bands, wet	SS-2 (18)	WH	
					WH	
			Black (10YR 2/2) CVC SAND, some		6	

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Northeast of KB18-11 (no coordinates available).

BOREHOLE LOG: KB18-11

DATE DRILLED: 6/7-6/8/2018

PROJECT INFORMATION

PROJECT: Buckeye/Hess Terminal Land Farm No.1
SITE LOCATION: Port Reading, NJ
PROJECT NO: 18626-01-02
KEY FIELD GEOLOGIST: Tracey Smith
GROUND SURFACE ELEVATION (ft): 9.71
NORTHING (ft): 564362.74
EASTING (ft): 629674.29
DATUM: NJSPCS NAD83, NAVD88

DRILLING INFORMATION

DRILLING CO: Unitech Drilling
DRILLER: Butch Hitzelberger/Mike Shepherd
DRILLING RIG: CME 55 LC and CME 750
DRILLING METHOD: HSA (3.25" ID)
SAMPLING METHOD: ASTMD D1586 SPT 2 in.
HAMMER TYPE: 140 lb. Auto Trip (30")
TOTAL BORING DEPTH (ft-bgs): 30
WATER LEVEL DURING DRILLING (ft-bgs): 2

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
	SM		gravel (1/4in.) angular			
			No Recovery		6	
10	SM		Dark brown (7YR 3/2) C Sandy SILT, some gravel (0.25in) angular	SS-3 (12)	3	
	SW		Black to dark brown (10YR 2/2) CVC SAND, wet		4	
			No Recovery		5	
					4	
	SW		Black to dark brown (10YR 2/1) CVC SAND, wet	SS-4 (13.2)	WH	
	Pt		Dark brown (7YR 3/3) silty PEAT, abundant organics, wet, organic odor		1	Top of PEAT 13.1 ft-bgs
			No Recovery		1	
					1	Acker 2" Vane and 12" Lower Force Arm ASTM D2573 Vane Shear Test 14 ft-bgs Peak: 380 in-lbs, 1965 psf Remolded: 150 in-lbs, 776 psf
	Pt		Dark brown (7YR 3/3) Silty clayey PEAT, trace organics, wet, organic odor	SS-5 (9.6)	1	
15					1	
			No Recovery		1	
					1	
	Pt		Dark brown (7YR 3/3) silty PEAT, trace organics, wet, organic odor	SS-6 (22.8)	1	Vane Shear Test 16 ft-bgs Peak: 275 in-lbs, 1422 psf Remolded: 125 in-lbs, 646 psf
					2	
					1	Shelby Tube Sample (ST1) from 17-19 ft-bgs Recovery 0/2 ft.
					1	
			No Recovery			
					2	

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Northeast of KB18-11 (no coordinates available).

BOREHOLE LOG: KB18-11

DATE DRILLED: 6/7-6/8/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Butch Hitzelberger/Mike Shepherd
PROJECT NO: 18626-01-02	DRILLING RIG: CME 55 LC and CME 750
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: HSA (3.25" ID)
GROUND SURFACE ELEVATION (ft): 9.71	SAMPLING METHOD: ASTMD D1586 SPT 2 in.
NORTHING (ft): 564362.74	HAMMER TYPE: 140 lb. Auto Trip (30")
EASTING (ft): 629674.29	TOTAL BORING DEPTH (ft-bgs): 30
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): 2

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
	Pt		Dark brown (7YR 3/3) silty PEAT, abundant organics, wet, organic odor	SS-7 (22.8)	1 1 1	
20			No Recovery	SS-8 (24)	WH 1 2 2	Shelby Tube Sample (ST2) from 20-22 ft-bgs Recovery 0/2 ft.
	Pt		Dark brown (7YR 3/3) silty PEAT, abundant organics 20-22 ft-bgs, some organics 22-24 ft-bgs, wet, organic odor	SS-9 (24)	1 1 1 2	Top of SAND 24.2 ft-bgs
	SP/GP		Reddish brown (5Y 2/5) MVC SAND and GRAVEL, angular	SS-10 (6)	WH WH WH 1	
25			No Recovery			
	SP/GP		Reddish brown (5YR 3/3) MVC SAND and GRAVEL, (0.125-0.25in.) angular-subangular, brick fragments, wet, no odor	SS-11 (16.8)	2 4 5	
			No Recovery		3	

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Northeast of KB18-11 (no coordinates available).

KEY ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: KB18-11

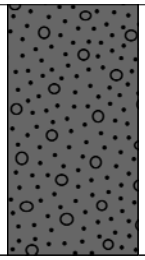
DATE DRILLED: 6/7-6/8/2018

PROJECT INFORMATION

PROJECT: Buckeye/Hess Terminal Land Farm No.1
SITE LOCATION: Port Reading, NJ
PROJECT NO: 18626-01-02
KEY FIELD GEOLOGIST: Tracey Smith
GROUND SURFACE ELEVATION (ft): 9.71
NORTHING (ft): 564362.74
EASTING (ft): 629674.29
DATUM: NJSPCS NAD83, NAVD88

DRILLING INFORMATION

DRILLING CO: Unitech Drilling
DRILLER: Butch Hitzelberger/Mike Shepherd
DRILLING RIG: CME 55 LC and CME 750
DRILLING METHOD: HSA (3.25" ID)
SAMPLING METHOD: ASTMD D1586 SPT 2 in.
HAMMER TYPE: 140 lb. Auto Trip (30")
TOTAL BORING DEPTH (ft-bgs): 30
WATER LEVEL DURING DRILLING (ft-bgs): 2

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
30	SP/GP		Reddish brown (5YR 3/3 to 2.5YR 3/3 at 28.8 ft-bgs) MVC SAND and GRAVEL, (0.125-0.25in.) angular-subangular, brick fragments, wet, no odor	SS-12 (20.4)	4 6 10 10	End of Boring - 30 ft-bgs

NOTES:

Top 6 ft of boring was cleared with air knife and hand auger. Vane Shear tests and Thin-walled tube samples completed in offset boring approx. 5 ft to Northeast of KB18-11 (no coordinates available).

BOREHOLE LOG: KHA18-2

DATE DRILLED: 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Tracey Smith
PROJECT NO: 18626-01-02	DRILLING RIG: NA
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: NA
GROUND SURFACE ELEVATION (ft): 13.99	SAMPLING METHOD: Hand Auger (3" OD)
NORTHING (ft): 564072.27	HAMMER TYPE: NA
EASTING (ft): 629623.10	TOTAL BORING DEPTH (ft-bgs): 3.5
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): NA

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	OL		Silty clayey topsoil, some brick and gravel fragments near bottom, water at 3 ft-bgs	Hand Auger 100%	Hand Auger NA	End of Boring - 3.5 ft-bgs
5						

NOTES:

BOREHOLE LOG: KHA18-4

DATE DRILLED: 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Tracey Smith
PROJECT NO: 18626-01-02	DRILLING RIG: NA
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: NA
GROUND SURFACE ELEVATION (ft): 12.23	SAMPLING METHOD: Hand Auger (3" OD)
NORTHING (ft): 564092.58	HAMMER TYPE: NA
EASTING (ft): 629781.41	TOTAL BORING DEPTH (ft-bgs): 5.3
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): NA

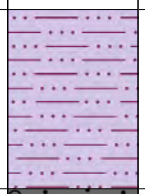
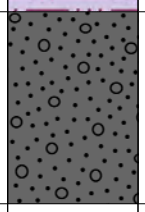
Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	GW		Gravel and Ash	Hand Auger 100%	Hand Auger NA	
	CH		Clay Liner Material			
	SW		Light brown FM SAND			
	SW/GW		Dark brown FM SAND and GRAVEL			
5						End of Boring - 5.3 ft-bgs

NOTES:

BOREHOLE LOG: KHA18-5

DATE DRILLED: 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Tracey Smith
PROJECT NO: 18626-01-02	DRILLING RIG: NA
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: NA
GROUND SURFACE ELEVATION (ft): 13.40	SAMPLING METHOD: Hand Auger (3" OD)
NORTHING (ft): 564021.28	HAMMER TYPE: NA
EASTING (ft): 629538.12	TOTAL BORING DEPTH (ft-bgs): 5
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): NA

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	GW		Gravel and Ash	Hand Auger 100%	Hand Auger NA	
	CH		Clay Liner Material			
	SW		Light brown FM silty SAND, some clay chunks			
	SW/GW		Dark brown FM SAND and GRAVEL			
5						End of Boring - 5 ft-bgs

NOTES:

BOREHOLE LOG: KHA18-6

DATE DRILLED: 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Tracey Smith
PROJECT NO: 18626-01-02	DRILLING RIG: NA
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: NA
GROUND SURFACE ELEVATION (ft): 16.12	SAMPLING METHOD: Hand Auger (3" OD)
NORTHING (ft): 564192.26	HAMMER TYPE: NA
EASTING (ft): 629458.71	TOTAL BORING DEPTH (ft-bgs): 6
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): NA

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	GW		Gravel and Ash	Hand Auger 100%	Hand Auger NA	
	CH		Clay Liner Material			
	SW		Light brown FM silty SAND, some clay chunks			
5						End of Boring - 6 ft-bgs

NOTES:

BOREHOLE LOG: KHA18-7

DATE DRILLED: 6/14/2018

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Buckeye/Hess Terminal Land Farm No.1	DRILLING CO: Unitech Drilling
SITE LOCATION: Port Reading, NJ	DRILLER: Tracey Smith
PROJECT NO: 18626-01-02	DRILLING RIG: NA
KEY FIELD GEOLOGIST: Tracey Smith	DRILLING METHOD: NA
GROUND SURFACE ELEVATION (ft): 12.73	SAMPLING METHOD: Hand Auger (3" OD)
NORTHING (ft): 564338.50	HAMMER TYPE: NA
EASTING (ft): 629681.56	TOTAL BORING DEPTH (ft-bgs): 5.25
DATUM: NJSPCS NAD83, NAVD88	WATER LEVEL DURING DRILLING (ft-bgs): NA

Depth (ft-bgs)	USCS	Lithology Log	Visual Manual Description	Sample ID Recov (in.)	Blow Count (N-Value)	Comments
0	GW		Gravel and Ash	Hand Auger 100%	Hand Auger NA	
	CH		Clay Liner Material			
	SW		Light brown FM SAND			
	SW		Dark brown FM silty SAND			
5						End of Boring - 5.25 ft-bgs

NOTES:

APPENDIX B

DESIGN CALCULATIONS

Computed: MRL	Date: 10/4/18	KEY ENVIRONMENTAL INCORPORATED	Client: Earth Systems
Checked: AEB	Date: 10/4/18		Project: No. 1 Landfarm
Page 1 of 5			Project No.: 18626-02
SUBJECT: Cap System Consolidation Settlement Estimate, No. 1 Landfarm, Former Port Reading Refining Facility			
Port Reading, NJ			

Objective:

Estimate the potential consolidation settlement and constructed slope for the No. 1 Landfarm Area Cap to ensure a post-construction slope of 3% (typical requirement).

Approach:

Based on an understanding of Site conditions, conservatively estimate the maximum differential settlement of the clsosure cap system. The maximum potential settlement may be estimated by utilizing the soil profile with the shallowest depth to and maximum thickness of the compressible soil layer, and assuming these conditions to be present under the point of maximum loading. Conservatively assume that the dike (outside edge of the Cap) will not settle. This will provide the maximum differential settlement estimate.

Cap Condition:

Figure 1 presents the exiting conditions plan view for the Landfarm Area that will be closed by cap construction. The northern portion is ~200 feeet by 360 feet with existing grades from 11 to 13 feet. The southern portion is ~240 feet by 120 feet with existing grades form 15 to 16 feet. The preimeter grades range from 10 to 11 feet. An ~3 feet high soil dike surrounds and defines the edge of the No. 1 Landform Area.

CALCULATION SHEET

Computed: MRL Date: 8/25/18 Checked: RD Date: 10/4/18	KEY ENVIRONMENTAL INCORPORATED	Client: HESS Corporation LF1 Project No.: 18626 Task: _____ Page 2 of 5

Subject: Cap Design

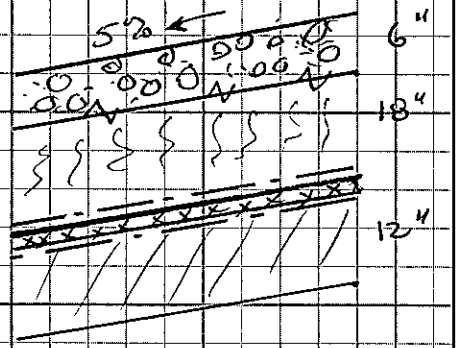
Proposed Cap Elements

A three foot thick cap (designated Cap Configuration 3) has been selected, layers as indicated in Sketch A, from bottom up as:

12" select landfarm soil
Geonet gas venting layer
Geosynthetic clay liner
40 mil LLDPE geomembrane
Geonet double sided with geotextile

18" Soil Fill
Non woven geotextile

6" Coarse aggregate



Sketch A
Not to scale

Assuming an initial constructed cap slope of 5% and a presumed conservative cap layout (see Figure 1), the slope rise = 7½ feet. The cap edge (Sketch B) detail shows that the cap perimeter will tie-in to the existing grade at elevation 12. Edge slope 5H:1V, 2 ft cover above geomembrane @ 5% => 2 ft Vertical x $\frac{5\text{ ft H}}{1\text{ ft V}}$ x 5% $\frac{V}{H}$ = ½ ft vertical, Therefore, peak elevation = perimeter (12 ft) + edge height (½ ft) + cover thickness (2 ft) + slope rise (7½ ft) = Elevation 22.

CALCULATION SHEET

Computed: MRL Date: 8/25/18 Checked: KB Date: 10/4/18	KEY ENVIRONMENTAL INCORPORATED	Client: Hess Corporation LF1 Project No.: 18626 Task: _____ Page 3 of 5

Subject: Cap Design

Geotechnical Investigation Results

Soil borings were completed around the perimeter of the landfarm unit with continuous split-spoon sampling and additional Shelby tube sampling. Figures 2 and 3 present the subsurface geologic sections. Conditions appear to be consistent beneath the landfarm unit. The only compressible material encountered is the peat material, as expected from historic site data. The thickness of the peat layer varied from 8½ to 14 feet with a top elevation ranging from -1 to -4.

Two shelby tube samples of the peat were sent to the geotechnical lab for testing. Consolidation tests were completed (see Plate KB18-08 and -09) with the following results:

	e_o	C_c	bulk density (pcf)
KB18-08	1.9454	0.95	97.2
KB18-09	1.8736	0.86	97.9

The preconsolidation pressures were greater than the current effective overburden pressure. However, conservatively the peat material will be considered normally consolidated.

CALCULATION SHEET

Computed: NRL Date: 8/25/18 Checked: RD Date: 10/4/18	KEY ENVIRONMENTAL INCORPORATED	Client: Hess Corporation LF1 Project No.: Task: Page 4 of 5

Subject: Cap Design

Analysis Method

The primary consolidation of the Peat material will be estimated using the one-dimensional consolidation equation for a normally consolidated soil:

$$P_c = \frac{H}{1+e_o}\left[C_c \log \frac{\sigma_o' + \Delta\sigma'}{\sigma_o'}\right]$$

Modeled Conditions

Load = Cap and Soil fill

Cap → ½ ft Gravel
2½ ft soil
use 5 lb/SF geomembrane weight & GCL etc.

(A) 1 ft sand } Landfill Unit
1 ft clay } drain / liner

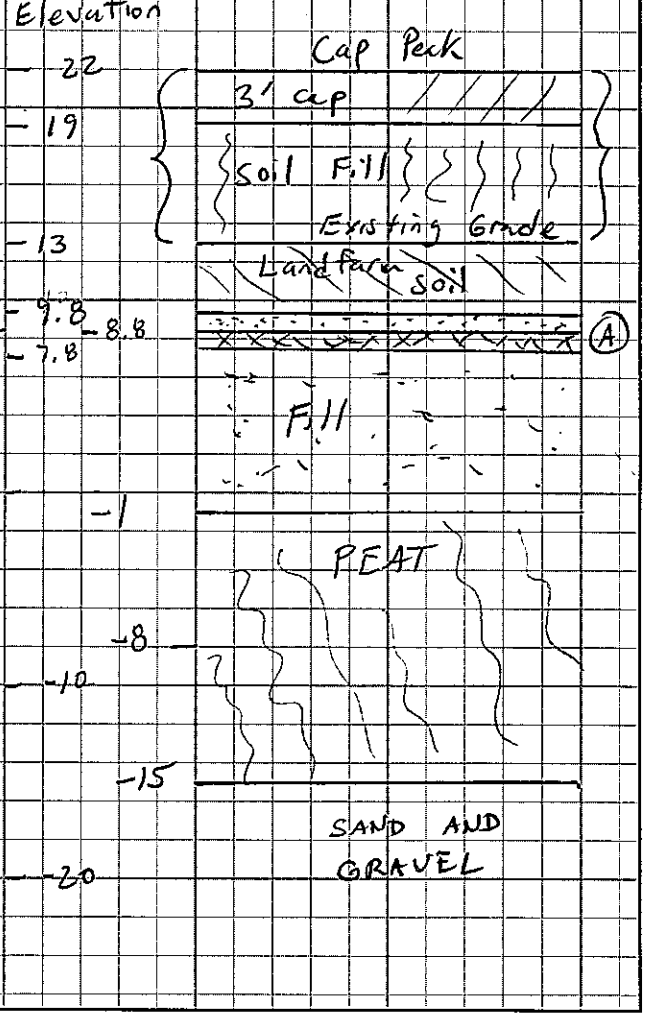
water @ EL 9

USE Peat Layer Top @ -1
with a 14 ft thickness = H

mid point of PEAT @ -8

Assigned Soil density:

	Gravel	130 pcf	
Cap	Soil	115 pcf	
	Soil Fill	115 pcf	
	Landfarm Soil	115 pcf	
	Sand	125 pcf	
	Clay	120 pcf	
	Fill	115 pcf	Peat 97.6 pcf



Computed: MPL Date: 8/25/18
Checked: AB Date: 10/4/18

KEY ENVIRONMENTAL INCORPORATED

Client: Hess Corporation LF1
Project No.:
Task: Page 5 of 5

Subject:

Results

Sheets 1 and 2 present the results of the estimated primary consolidation settlement, ranging from 1 to 1.2 feet.

change in slope = $\frac{1.2 \text{ feet}}{150 \text{ feet}} = 0.8\%$.

Therefore, minimum design slope = 3% + 0.8%
≅ 4% slope.

Use of Results

If fill thicknesses vary by more than 10% from those used herein, then this evaluation should be assessed / revised.

This analysis is based on the limited testing program and results available at the time.

The presence of compressible units at greater depths is unknown and could result in greater total settlements.

PRIMARY CONSOLIDATION SETTLEMENT CALCULATION SHEET **Sheet #2**

PROJECT: HESS Corporation
LOCATION: Land Farm 1
LOAD CASE: Final Cap Loading

Done By: MRL Date: 10/4/2018
Checked By: AEB Date: 10/4/2018
Data Entry Checked by: MAW Date: 10/4/2018

Elevation	Layer	Total Unit Weight (PCF)	Layer Thickness (feet)	Layer Total Overburden Stress (PSF)	Layer Pore Pressure (PSF)	Initial Layer Effective Stress (PSF)	Initial Cumulative Effective Stress (PSF)	Final Load Stress (PSF)	Note
22	Surface Load			5				5	Synthetics, etc.
22	Gravel	130	0.5	65				70.00	Cap Peak
21.5	General Soil Fill	115	8.5	977.5				1047.50	
13	Soil Fill	115	3.2	368	0	368.0	368.0		Existing Grade
9.8	Sand	125	1	125	0	125.0	493.0		
8.8	Clay, Saturated	120	1	120	62.4	57.6	550.6		Groundwater
7.8	Fill	115	8.8	1012	549.12	462.9	1013.5		
-1	Peat	97.2	7	680.4	436.8	243.6	1257.1		Midpoint
-8	Peat	97.2	7	680.4	436.8	243.6	1500.7		
-15	Sand / Gravel	128					1500.7		
							1500.7		

Peat Layer			
	Layer Thickness	14	feet
	Initital Void Ratio	1.9454	
	Initial Midpoint Effective Stress	1257.1	psf
	Stress Increase from Loading	1047.5	psf
	Stress Ratio	0.83	
	Cc	0.95	Normal
	Consolidation	1.2	feet

Sample KB18-08 Results

	Layer Thickness		feet
	Initital Void Ratio		
	Initial Midpoint Effective Stress		psf
	Stress Increase from Loading		psf
	Stress Ratio		
	Cc		
	Consolidation		feet

Estimated Settlement = 1.2 feet
14.3 Inches

PRIMARY CONSOLIDATION SETTLEMENT CALCULATION SHEET **Sheet #1**

PROJECT: HESS Corporation — Done By: MRL — Date: 10/4/2018
LOCATION: Land Farm 1 — Checked By: AEB — Date: 10/4/2018
LOAD CASE: Final Cap Loading — Data Entry Checked by: MAW — Date: 10/4/2018

Elevation	Layer	Total Unit Weight (PCF)	Layer Thickness (feet)	Layer Total Overburden Stress (PSF)	Layer Pore Pressure (PSF)	Initial Layer Effective Stress (PSF)	Initial Cumulative Effective Stress (PSF)	Final Load Stress (PSF)	Note
22	Surface Load			5				5	Synthetics, etc.
22	Gravel	130	0.5	65				70.00	Cap Peak
21.5	General Soil Fill	115	8.5	977.5				1047.50	
13	Soil Fill	115	3.2	368	0	368.0	368.0		Existing Grade
9.8	Sand	125	1	125	0	125.0	493.0		
8.8	Clay, Saturated	120	1	120	62.4	57.6	550.6		Groundwater
7.8	Fill	115	8.8	1012	549.12	462.9	1013.5		
-1	Peat	97.9	7	685.3	436.8	248.5	1262.0		Midpoint
-8	Peat	97.9	7	685.3	436.8	248.5	1510.5		
-15	Sand / Gravel	128					1510.5		
							1510.5		

Peat Layer			
Layer Thickness		14	feet
Initital Void Ratio		1.8736	
Initial Midpoint Effective Stress		1262.0	psf
Stress Increase from Loading		1047.5	psf
	Stress Ratio	0.83	
	Cc	0.86	Normal
	Consolidation	1.1	feet

Sample KB18-09 Results

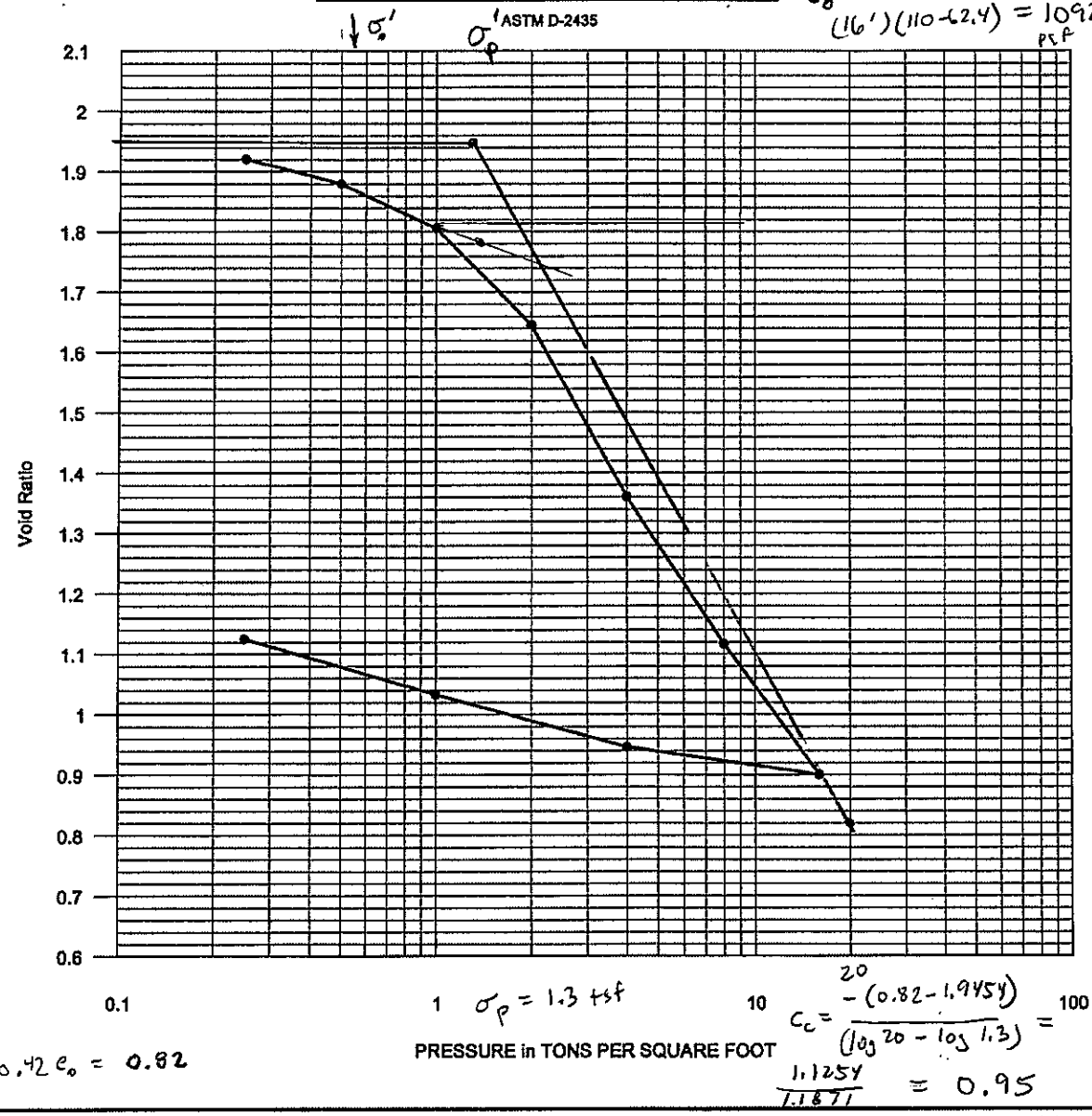
Layer Thickness			feet
Initital Void Ratio			
Initial Midpoint Effective Stress			psf
Stress Increase from Loading			psf
	Stress Ratio		
	Cc		
	Consolidation		feet

Estimated Settlement = 1.1 feet
13.2 Inches

CONSOLIDATION TEST RESULTS

VOID RATIO vs PRESSURE

$\sigma_o' = (3')(110\ pcf) + (16')(110-62.4) = 1092\ psf$



$\sigma_p = 1.3$ tsf

$0.42\ e_o = 0.82$

$C_c = \frac{-(0.82-1.9454)}{(\log 20 - \log 1.3)} = \frac{1.1254}{1.1871} = 0.95$

MATERIAL DESCRIPTION:		
Shelby Tube		
1AOC-C1 Tank		
Non Firous Peat		
TEST SPECIMEN PROPERTIES	INITIAL	FINAL
Water Content, %	73.65	44.84
Void Ratio	1.9454	1.0258
Saturation, %	99.95	99.98
Sample Height, inches	1.0000	0.6878
Unit Dry Weight, pcf	55.98	81.36
Sample Diameter, inches	2.50	2.50
Liquid Limit, %	51	
Plastic Limit , %	40	
Plasticity Index, %	11	
Specific Gravity	2.64	Assumed

CONSOLIDATION PROPERTIES				
Compression Index			Preconsolidation Stress,tsf	
Recompression Index			Existing Overburden Stress,tsf	
Swell Index				

CONSOLIDATION TEST RESULTS			
Client:	Key Environmental	Project No:	18LS3685.01
Project :	No 1 Land Farm Port Reading , NJ	Date:	43287.2997
Boring:	KB18-08	Perf'd By:	MLB
Sample :	Offset ST-1	Chk'd By:	JBJr.
Depth:	17 to 19 ft		

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PLATE KB18- 08

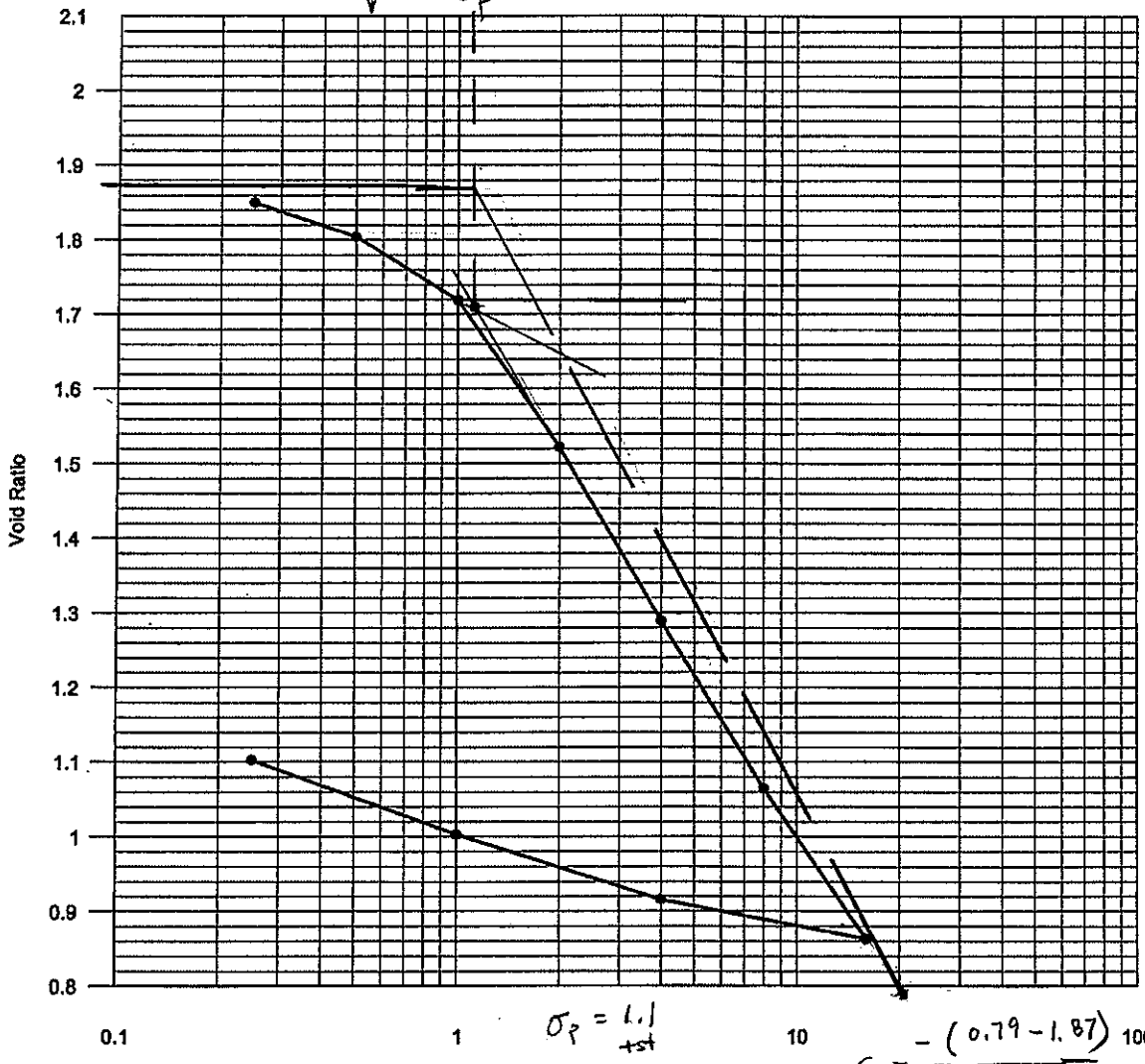
$\gamma_m = (1.7365)(55.96) = 97.2$ pcf

CONSOLIDATION TEST RESULTS

VOID RATIO vs PRESSURE

ASTM D-2435

$\sigma_o' = (3')(110\ pcf) + (16')(110 - 62.4\ pcf)$
$= 1092\ pcf = 0.55\ tsf$



$C_c = \frac{-(0.79 - 1.87)}{(\log 20 - \log 1.1)} = \frac{1.0836}{1.2596} = 0.86$

MATERIAL DESCRIPTION:		
Shelby Tube 1AOC-C1 Tank Non Firous Peat		
TEST SPECIMEN PROPERTIES	INITIAL	FINAL
Water Content, %	70.64	40.47
Void Ratio	1.8736	1.0690
Saturation, %	99.53	99.95
Sample Height, inches	1.0000	0.7200
Unit Dry Weight, pcf	57.35	79.66
Sample Diameter, inches	2.50	2.50
Liquid Limit, %	55	
Plastic Limit , %	41	
Plasticity Index, %	14	
Specific Gravity	2.64	Assumed

CONSOLIDATION PROPERTIES			
Compression Index		Preconsolidation Stress,tsf	
Recompression Index		Existing Overburden Stress,tsf	
Swell Index			

CONSOLIDATION TEST RESULTS

Client:	Key Environmental	Project No:	18LS3685.01
Project :	No 1 Land Farm Port reading , NJ	Date:	43287.3109
Boring:	KB18-09	Perf'd By:	MLB
Sample :	Offset ST-1	Chk'd By:	JBJr.
Depth:	17 to 19 ft		

JLT Laboratories, Inc.

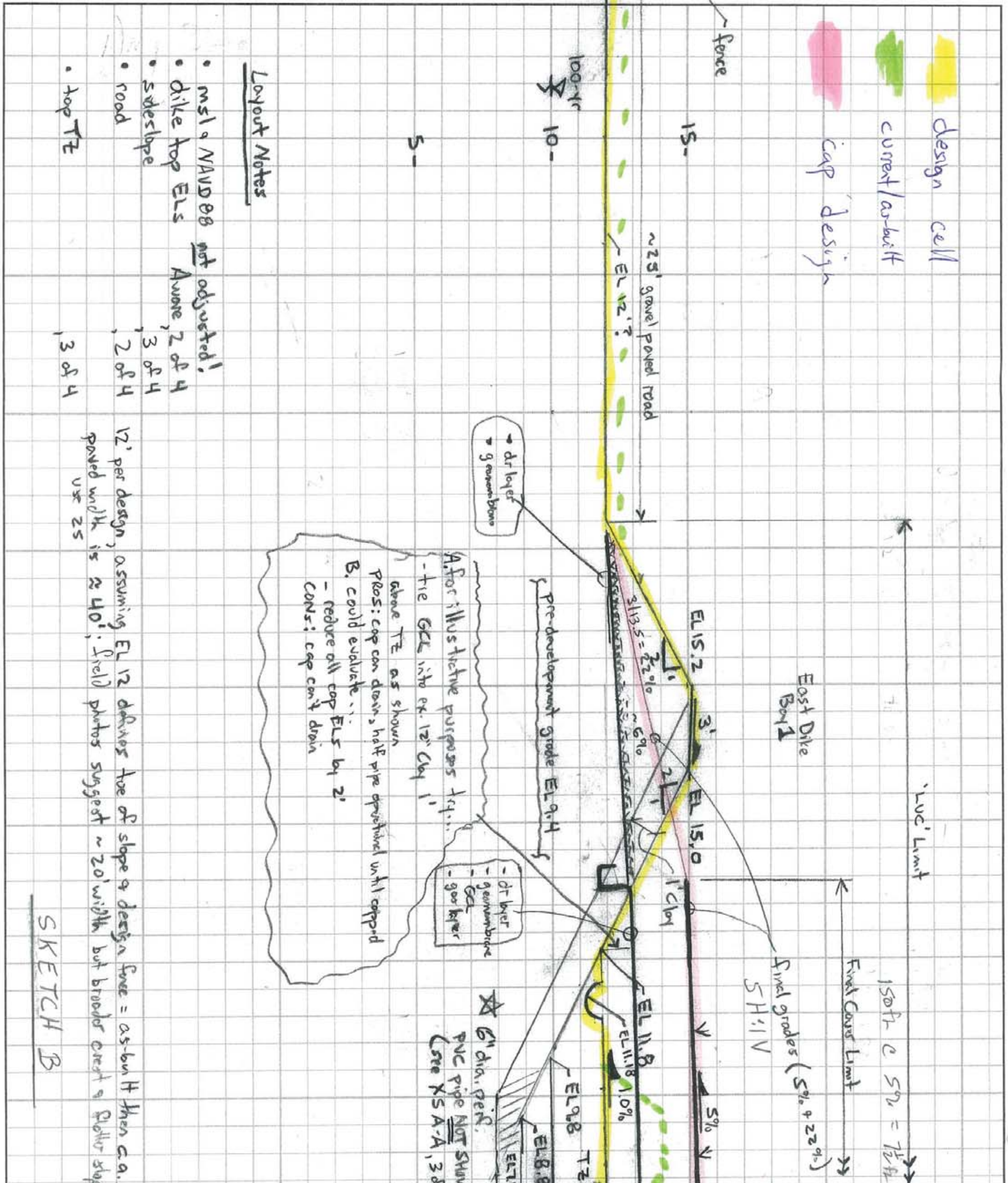
PLATE KB18- 09

$\gamma_m = (1.7064)(57.35) = 97.9\ pcf$

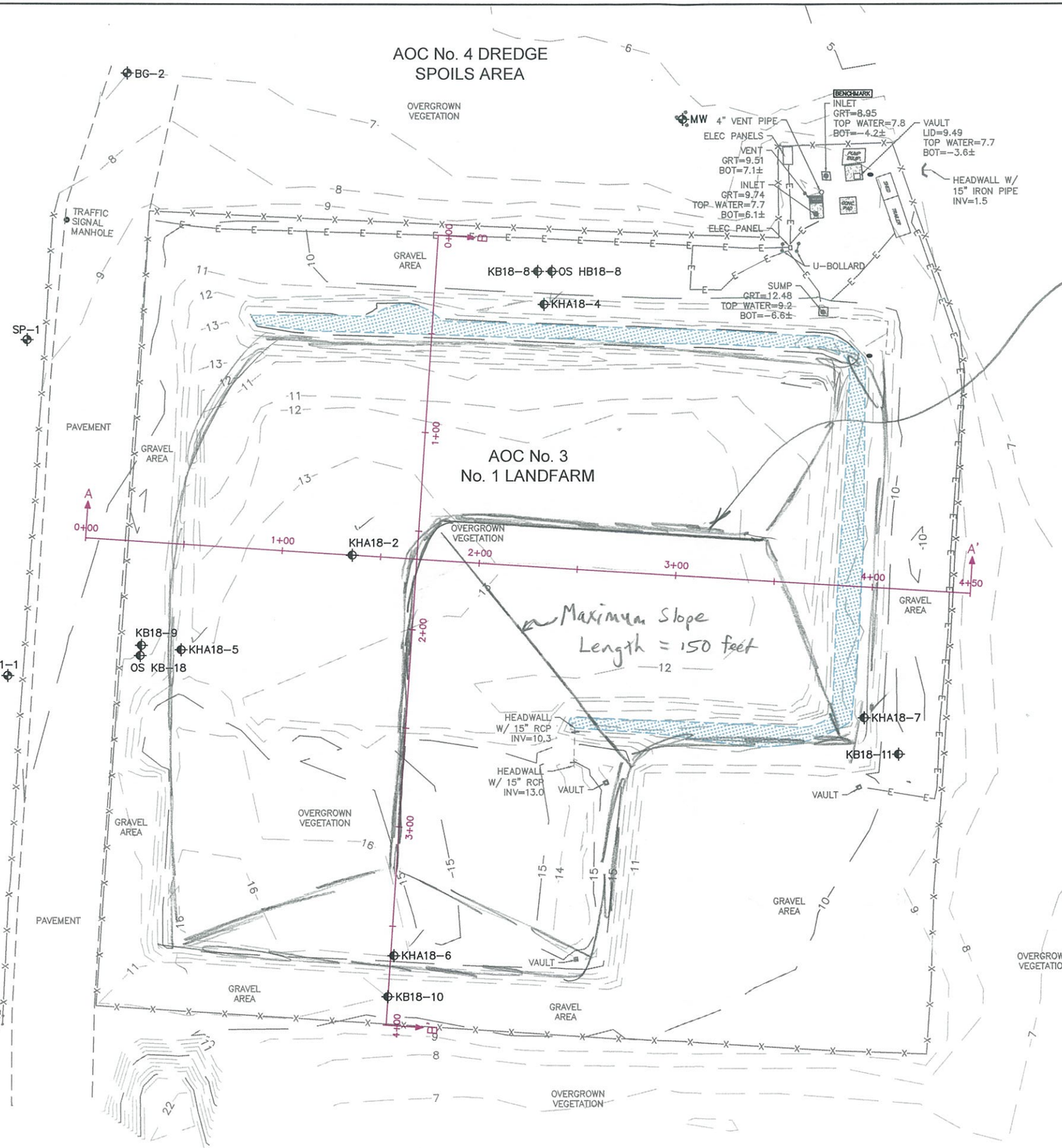
CALCULATION SHEET

Computed: RCM	Date: 2/26/18	KEY ENVIRONMENTAL INCORPORATED	Client:
Checked:	Date:		Project No.:
			Task: Page of

Subject: Initial Conceptual Final Cover Termination
LF1, Port Reading, NJ



Layout Notes
• msl ≈ NAVD88 not adjusted!
• dike top ELs Avove, 2 of 4
• sideslope, 3 of 4
• road, 2 of 4
• top TZ, 3 of 4
12' per design, assuming EL 12 defines toe of slope ≈ design fence = as-built then c.a. paved width is ≈ 40'; field photos suggest ~20' width but broader crest ≈ flatter slope
use 25
SKETCH B
design cell
current/as-built
cap design
fence
15-
10-
5-
100-yr
~25' gravel paved road
EL 12'?
• dr layer
• geomembrane
Pre-development grade EL 9.4
A. for illustrative purposes try...
- tie GCL into ex. 12" Clay 1' above TZ as shown
PROS: cap can drain, half pipe operational until capped
B. could evaluate...
- reduce all cap ELs by 2'
CONS: cap can't drain
EL 15.2
East Dike Bay 1
3'
EL 15.0
1' Clay
- dr layer
- geomembrane
- GCL
- geo layer
6" dia. perf. PVC Pipe NOT SHOWN (see XS A-A, 3 of 4)
EL 11.8
EL 11.18
1.0%
EL 9.8
EL 8.8
EL 7.8
Clay
Sand
TZ
5%
final grades (5% + 22%)
5H:1V
Final Cover Limit
150 ft @ 5% = 7.5 ft
'LUC' Limit



LEGEND

- L1-1 — MONITORING WELL
- KHA18-5 — SOIL BORING
- 6" CHAIN LINK FENCE
- ELECTRIC LINE
- STANDING WATER

Likely Capping Surface Layout

assume cap slope @ 5%

slope height rise = slope length x cap slope

= (150 ft)(0.05 ft/ft)

= 7½ ft

0 60 120 FEET

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 08/22/18	KEY ENVIRONMENTAL INCORPORATED
CHKD:	DATE:	
APPD:	DATE:	
SCALE:	AS SHOWN	

GEOTECHNICAL INVESTIGATION
HESS CORPORATION
FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

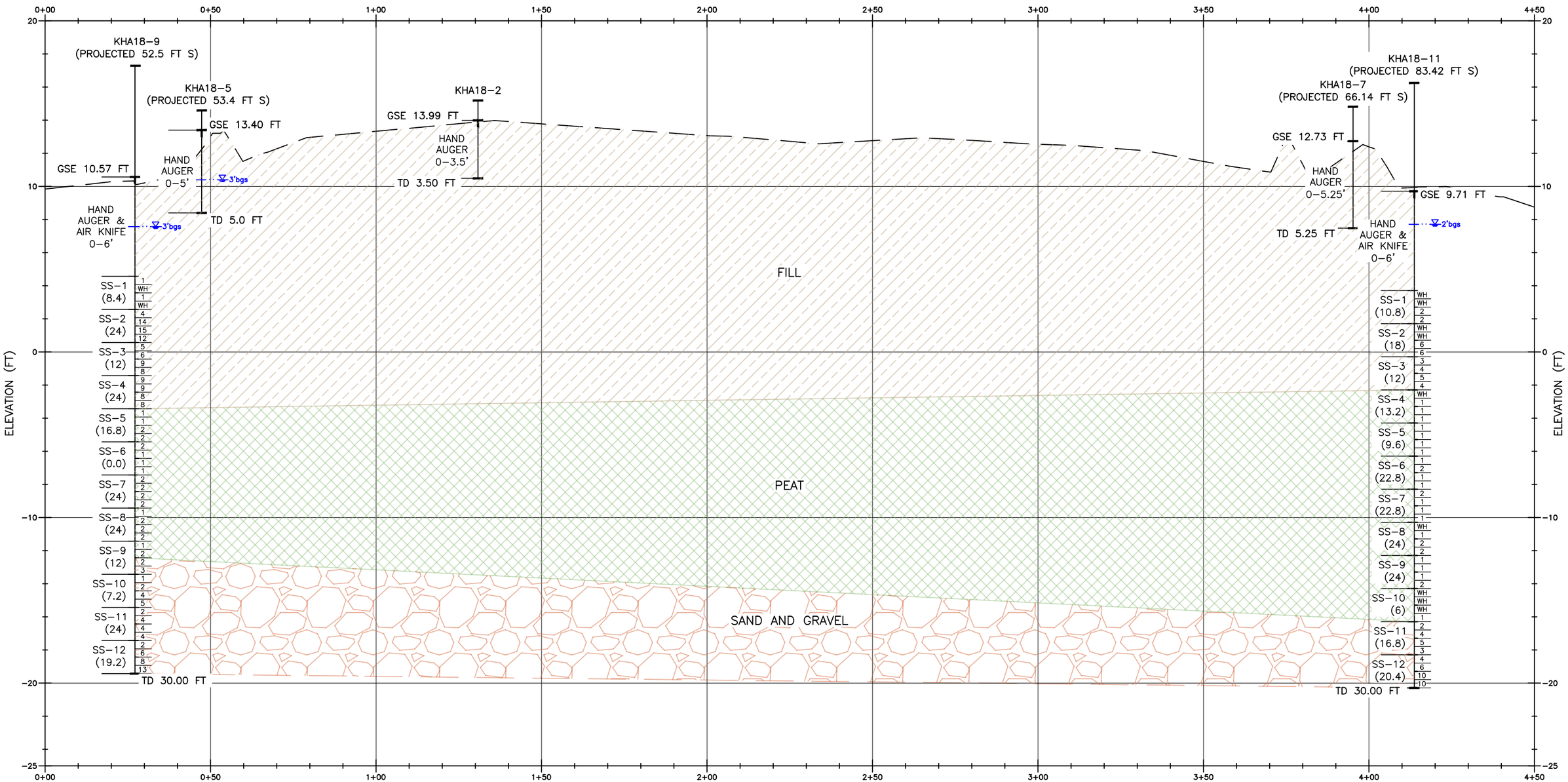
PLAN VIEW — PROJECT NO: 18-626 — FIGURE 1

REV	DATE	DESCRIPTION	APPD

REFERENCE:

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106



LEGEND

- EXISTING GROUND SURFACE
- WATER LEVEL AT TIME OF BORING
- T — TOP OF BORING/ GROUND SURFACE
- SS-1 — SPLIT SPOON SAMPLE ID
- (8.4) — RECOVERY OF SPLIT SPOON IN INCHES OUT OF 24"
- 1 WH 1 WH — STANDARD PENETRATION TEST BLOW COUNT VALUES
- FILL
- PEAT
- SAND AND GRAVEL
- GSE — GROUND SURFACE ELEVATION
- TD — TOTAL DEPTH

FIG 1

CROSS-SECTION A-A'

V: 0 6 12 FEET

H: 0 30 60 FEET

NOTES:

1. REFER TO FIGURE 1 FOR BORING LOCATION PLAN.
2. OFFSET BORINGS ARE NOT SHOWN.
3. LITHOLOGIC INTERVALS INDICATED HEREON MAY DIFFER FROM BORING LOGS. LITHOLOGY INDICATED HEREON REPRESENTS A CONSERVATIVE INTERPRETATION OF BORING LOGS FOR PURPOSES OF GEOTECHNICAL EVALUATION.

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

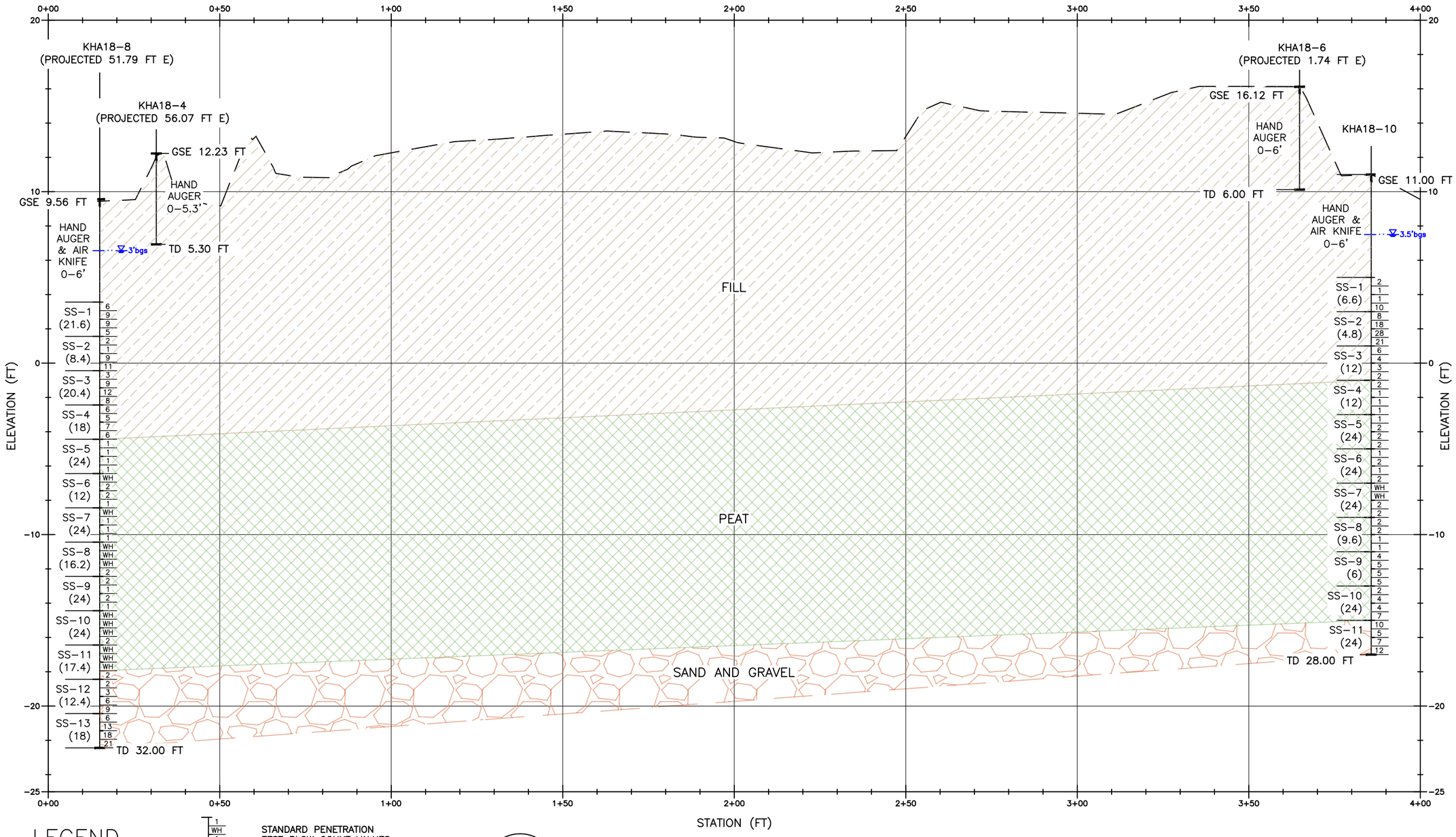
DRWN: ERM	DATE: 08/22/18	KEY ENVIRONMENTAL INCORPORATED
CHKD: RCM	DATE: 09/15/18	
APPD:	DATE:	
SCALE:	AS SHOWN	

GEOTECHNICAL INVESTIGATION
AOC-3: NO. 1 LANDFARM
HESS CORPORATION – FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

CROSS SECTION A-A'

PROJECT NO: 18-626

FIGURE 2



LEGEND

- EXISTING GROUND SURFACE
- WATER LEVEL AT TIME OF BORING
- T — TOP OF BORING/ GROUND SURFACE
- SS-1 / (8.4) — SPLIT SPOON SAMPLE ID / RECOVERY OF SPLIT SPOON IN INCHES OUT OF 24"
- 1 / WH / 1 / WH — STANDARD PENETRATION TEST BLOW COUNT VALUES
- FILL
- PEAT
- SAND AND GRAVEL
- GSE — GROUND SURFACE ELEVATION
- TD — TOTAL DEPTH

2 / FIG 1

CROSS-SECTION B-B'

NOTES:

1. REFER TO FIGURE 1 FOR BORING LOCATION PLAN.
2. OFFSET BORINGS ARE NOT SHOWN.
3. LITHOLOGIC INTERVALS INDICATED HEREON MAY DIFFER FROM BORING LOGS. LITHOLOGY INDICATED HEREON REPRESENTS A CONSERVATIVE INTERPRETATION OF BORING LOGS FOR PURPOSES OF GEOTECHNICAL EVALUATION.

V: 0 6 12 FEET

H: 0 30 60 FEET

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
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EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 08/22/18	KEY ENVIRONMENTAL INCORPORATED	
CHKD: RCM	DATE: 09/15/18		
APPD:	DATE:		
SCALE:	AS SHOWN		

GEOTECHNICAL INVESTIGATION
AOC-3: NO.1 LANDFARM
HESS CORPORATION – FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

CROSS SECTION B-B'

PROJECT NO: 18-626

FIGURE 3

y:\00civil\earth systems\port reading\production drawings\2_geotechnical investigation\Figure 1-3 - plan & sections.dwg Last Saved By: Mkeck 10/4/2018 1:19 PM Plotted By: Mark Keck 10/9/2018 9:08 AM Scale: 1:1

Computed: MRL		Date: 9/24/18	KEY ENVIRONMENTAL INCORPORATED	Client: Earth Systems
Checked: RCM		Date: 10/01/18		Project: No. 1 Landfarm
Page 1	of 8			Project No.: 18626-02
SUBJECT: Veneer Slope Stability, Cap System, No. 1 Landfarm, Hess Corporation - Former Port Reading Refining Facility				
Middlesex County, Port Reading, NJ				

Objective: Determine the maximum allowable cap plateau slope to maintain a stable geosynthetic cap/cover soil system for the No. 1 Landfarm area cap.

References:

1 Figure 1 - Coarse Aggregate Surfaced Cap system.
2 Geosynthetic Fundamentals in Landfill Design, G. N. Richardson, Aigen Zhao, September 8-10, 2009, Proceedings of International Symposium on Geoenvironmental Engineering, Hangzhou, China.
3 Naval Facilities Engineering Command, Design Manual 7.2, Foundations & Earth Structures, Table 1, Typical Properties of Compacted Soils, page 7.2-39.
4 Internal and Interface Shear Strength of Geosynthetic Clay Liners (GCLs), Geotechnical Research Report, McCartney, Zornberg, and Swan, May 2002.
5 Geosynthetic interface shear strength - Geosynthetic Research Institute - GRI30 Appendix Table 1.
6 Koerner, R. M. 2012, Designing with Geosynthetics, 6th Edition, Xlibris Corp.
7 Thiel, Richard. Peak vs Residual Shear Strength for Landfill Bottom Liner Stability Analyses, Thiel Engineering, Oregon House CA, USA.

Method: The Cap design consists of a geocomposite gas venting layer, geosynthetic clay liner, geomembrane, geocomposite drainage layer, covered by soil with geotextile and aggregate surface treatment. The U.S. EPA / NJDEP regulated grades are expected to range between 3% and 5%. Using infinite slope stability analysis, the proposed material interface friction values, and the resulting Factors of Safety were evaluated.

Step 1: Determine the interface friction (shear strength) between layers in the cap system (Figure 1) to identify the potential critical slip surface. From the bottom upward, based on published interface friction results, the interface layers are:

Interface 1 **Common Fill and the Geocomposite Gas Vent Layer**
The common fill or select landfarm material is expected to be a silty-sand material with an estimated compacted friction angle of at least 25 (reference 3). The Geocomposite Gas Venting Layer material will be faced on the bottom with a nonwoven (NW) needle-punched (NP) geotextile. Based on Table 1 (reference 5), the interface friction angle for a NW-NP geotextile to granular soil is 27 peak and 21 residual.
Use δ = 21

Interface 2 **Geocomposite Gas Vent Layer and Geosynthetic Clay Liner**
The Geocomposite Gas Venting material will be faced with a nonwoven needle-punched geotextile on the bottom with the top exposed geonet against the bottom geotextile of the GCL. Based on Table 1 (reference 5), the interface friction angle for a geonet to NW NP geotextile is 23 peak and 16 residual.
Use δ = 16

Interface 3 **Geosynthetic Clay Liner and Smooth LLDPE Geomembrane**
The linear best-fit results from Table 5.26 (reference 4) for GCL to smooth LLDPE, the interface shear is 12.1 peak and residual.
Use δ = 12

Interface 4 **Smooth LLDPE Geomembrane and Geocomposite Drainage Layer**
Based on Table 1 (reference 5) for the LLDPE-Smooth and the NW NP geotextile portion of the geocomposite drainage layer, the interface friction angle is 10 peak and 9 residual.
Use δ = 9

Interface 5 and 6 **Geocomposite Drainage Layer and Common Fill**
The common fill is expected to be a silty-sand material with an estimated compacted friction angle of at least 25 (reference 3). The Geocomposite Drainage Layer will be faced on the top with a NW NP geotextile. Based on Table 1 (reference 5), the interface friction angle NW NP geotextile portion of a geocomposite to granular soil is 27 peak and 21 residual.
Use δ = 21

Result: **Interface 4 controls, use $\delta = 9$.**

Step 2: For the proposed capping system slope, determine the maximum slope based on the critical interface friction angle for a Factor of Safety = 1.5.
Existing design slope = 5% or 2.86 .

FS_{slope} = Resisting Forces / Driving Forces

$FS_{slope} = \tan\delta\,[1 - (\gamma_w h_w) / (\gamma_t d)] / \tan\beta$ (ref. 3, assuming no resisting force gained from soil cohesion and no seismic conditions)

β = slope angle of the landfill cap system

δ = cap system component interface friction angle or soil internal friction angle
d = thickness of cover soil = 2 ft
h_w = height of water above interface surface, max = 1.5 feet. (Note cap final surface is a 6 inch cover aggregate layer.)
γ_w = unit weight of water = 62.4 pcf
γ_t = unit weight of soil (USCS SM-SC) = 120 pcf
FS_{slope} = Minimum factor of safety against sliding for soil/geocomposite or geocomposite/geomembrane interface ≥ 1.5

Solution: 5% (2.9) slope

The geocomposite drainage layer is expected to convey the maximum infiltration, and the overlaying cover soil will remain drained. Therefore, the saturated layer ("h_w") will be less than or equal to the thickness of the geocomposite drainage layer which is estimated to be 0.6 cm or 0.24 inches.

a. $h_w = 0$ First, check the minimum interface friction angle required to provide a $FS_{slope} \geq 1.5$ when "h_w" = 0.

$$FS_{slope} = \frac{\tan \delta}{\tan \beta}$$ (ref. 2)

determine δ so the $FS_{slope} = 1.5$
$\tan \beta * FS_{slope} = \tan \delta$
$\delta = \tan^{-1} (\tan \beta * FS_{slope})$ where $\beta = 2.9°$ for 5% slope
$\delta = 4.3°$ < critical interface, OK.

b. $h_w > 0$ Determine the required δ if the common fill layer becomes saturated, with a Factor of Safety = 1.5.
$\tan \delta = [FS \times (\tan \beta) / (1 - (\gamma_w h_w)/(\gamma_t d))$ (ref. 3)
For Hw = 1.5 feet, d = 2 feet

h_w (ft)	tan δ	δ (degrees)	
0.00	0.076	4.3	
0.025	0.076	4.4	= geocomposite drainage layer thickness
0.50	0.087	5.0	
1.00	0.103	5.9	
1.50	0.125	7.1	= maximum saturated thickness
2.00	0.125	7.1	= if coarse aggregate was also saturated, yields a FS = 1.18 > 1.1. Acceptable for highly unlikely condition.

Check above equation with simplified equation for fully saturated layer:

FS = resisting forces/driving forces = $(\gamma_b * \tan\delta) / (\gamma_{sat} * \tan\beta)$ (ref. 2)
where $\gamma_b = \gamma_t - \gamma_w$ = 120 pcf - 62.4 pcf = 57.6 pcf
FS = (57.6 pcf * tan 9°) / (120 pcf *tan 2.9°) = 1.5

The factor of safety against sliding was estimated to be ≥ 1.5 given a 2 ft thick cover layer with a slope less than or equal to 5% is saturated to 1.5 feet, flow parallel to the slope, for the entire slope length provided the minimum internal shear strength or interface (δ) is at least 7.1°.

Solution: **6.5% (3.7) slope**

a. $h_w = 0$ First, determine the interface friction angle required to provide a $FS_{slope} \geq 1.5$ when "h_w" = 0.

$$FS_{slope} = \frac{\tan \delta}{\tan \beta} \quad \text{(ref. 2)}$$

determine δ so the $FS_{slope} = 1.5$

$\tan \beta * FS_{slope} = \tan \delta$

$\delta = \tan^{-1} (\tan \beta * FS_{slope})$, where $\beta = 4°$ for 7% slope

$\delta = 6°$

b. $h_w > 0$ Determine the required δ if the common fill layer becomes saturated, with a Factor of Safety = 1.5.
(i. e., determine δ to achieve FS = 1.5 with increasing head in cover layer)

$\tan \delta = [1.5 (\tan \beta) / (1 - (\gamma_w h_w) / (\gamma_t d))$ (ref. 3)

h_w (ft)	tanδ	δ (degrees)	
0.00	0.097	5.5	
0.025	0.098	5.6	= geocomposite drainage layer thickness
0.50	0.111	6.4	
1.00	0.131	7.5	
1.50	0.159	9.0	= maximum saturated thickness
2.00	0.158	9.0	= if coarse aggregate was also saturated, Yields a FS = 1.17 > 1.1. Acceptable for highly unlikely condition.

Check above equation with simplified equation for fully saturated layer:

FS = resisting forces/driving forces = $(\gamma_b * \tan\delta) / (\gamma_{sat} * \tan\beta)$ (ref. 2)

where $\gamma_b = \gamma_t - \gamma_w$ = 120 pcf - 62.4 pcf = 57.6 pcf

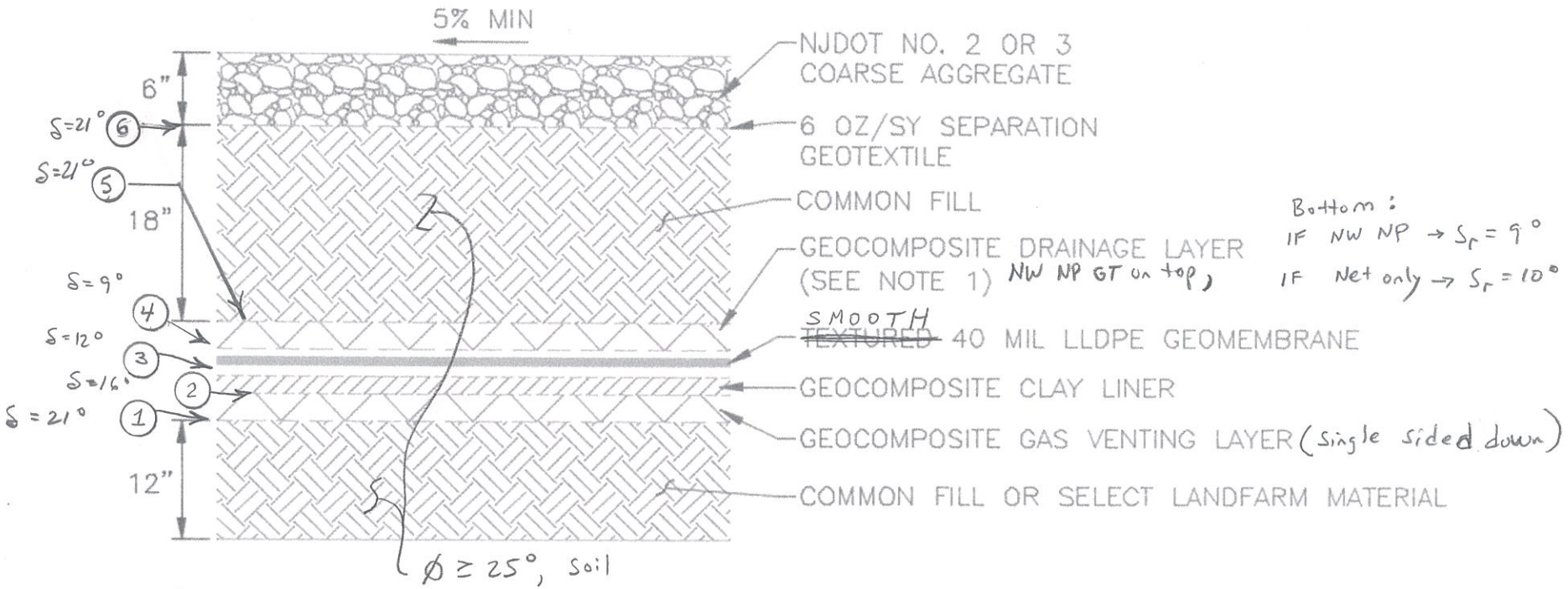
FS = (57.6 pcf * tan 9) / (120 pcf * tan 3.7) = 1.2. Greater than 1.1, even for the temporary highly unlikely condition of full saturation through the aggregate layer. Ok

Summary: Evaluating both a 5% grade and a 6.5% grade with 1) a drainage maintained within the geocomposite drainage layer and 2) a saturated cover material (h_w = 1.5 feet), it was determined that a cap with up to a 6.5% grade is stable.

Conclusions: For the proposed No. 1 Landfarm Area capping system, a critical interface friction angle of $\delta = 9°$ is required to maintain a FS $\geq$ 1.5, with a cap placed at a 6.5% grade (1V:9H) and the 1.5' cover soil is fully saturated. The current design is for a cap with a 5% grade.

Based on a review of available technical published literature, all peak and residual interface friction angles for the proposed cap system are anticipated to be greater than or equal to the required critical interface friction angle of 9 . Site specific interface friction testing is not warranted.

Actual values are site specific, and may vary with geosynthetic brand and style number, site specific soil, loading, shear rate, and moisture conditions. Therefore, it is suggested that Site specific materials be evaluated for conformance, prior to installation at the Site.



1 / LF1-C-504 COARSE AGGREGATE SURFACE CAP
N.T.S.

Figure 1

Note

Interface 5 & 6 are the same materials.

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TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective Stress Envelope Degrees)	Tan ϕ			
				Percent of Original Height								
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical stength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
   (..) indicates insufficient data available for an estimate.

Reference: p. 7.2-39 of NAVFAC DM-7.2. September 1986.

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Appendix Table 1. Summary of interface shear strengths.

Interface 1*	Interface 2*	Peak Strength Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Residual Strength Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
HDPE-S	Granular Soil	1a	21	0	162	0.93	1b	17	0	128	0.92
HDPE-S	Cohesive Soil										
	Saturated	1c	11	7	79	0.94	1d	11	0	59	0.95
	Unsaturated	1c	22	0	44	0.93	1d	18	0	32	0.93
HDPE-S	NW-NP GT	1e	11	0	149	0.93	1f	9	0	82	0.96
HDPE-S	Geonet	1g	11	0	196	0.90	1h	9	0	118	0.93
HDPE-S	Geocomposite	1i	15	0	36	0.97	1j	12	0	30	0.93
HDPE-T	Granular Soil	2a	34	0	251	0.98	2b	31	0	239	0.96
HDPE-T	Cohesive Soil										
	Saturated	2c	18	10	167	0.93	2d	16	0	150	0.90
	Unsaturated	2c	19	23	62	0.91	2d	22	0	35	0.93
HDPE-T	NW-NP GT	2e	25	8	254	0.96	2f	17	0	217	0.95
HDPE-T	Geonet	2g	13	0	31	0.99	2h	10	0	27	0.99
HDPE-T	Geocomposite	2i	26	0	168	0.95	2j	15	0	164	0.94
LLDPE-S	Granular Soil	3a	27	0	6	1.00	3b	24	0	9	1.00
LLDPE-S	Cohesive Soil	3c	11	12.4	12	0.94	3d	12	3.7	9	0.93
LLDPE-S	NW-NP GT	3e	10	0	23	0.63	3f	9	0	23	0.49
LLDPE-S	Geonet	3g	11	0	9	0.99	3h	10	0	9	1.00
LLDPE-T	Granular Soil	4a	26	7.7	12	0.95	4b	25	5.2	12	0.95
LLDPE-T	Cohesive Soil	4c	21	5.8	12	1.00	4d	13	7.0	9	0.98
LLDPE-T	NW-NP GT	4e	26	8.1	9	1.00	4f	17	9.5	9	0.96
LLDPE-T	Geonet	4g	15	3.6	6	0.97	4h	11	0	6	0.98
PVC-S	Granular Soil	5a	26	0.4	6	0.99	5b	19	0	6	0.99
PVC-S	Cohesive Soil	5c	22	0.9	11	0.88	5d	15	0	9	0.95
PVC-S	NW-NP GT	5e	20	0	89	0.91	5f	16	0	83	0.74
PVC-S	NW-HB GT	5g	18	0	3	1.00	5h	12	0.1	3	1.00
PVC-S	Woven GT	5i	17	0	6	0.54	5j	7	0	6	0.93
PVC-S	Geonet	5k	18	0.1	3	1.00	5l	16	0.6	3	1.00

Appendix Table 1. (continued)

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
PVC-F	NW-NP GT	6a	27	0.2	26	0.95	6b	23	0	26	0.95
PVC-F	NW-HB GT	6c	30	0	8	0.97	6d	27	0	8	0.90
PVC-F	Woven GT	6e	15	0	6	0.78	6f	10	0	6	0.76
PVC-F	Geonet	6g	25	0	11	1.00	6h	19	0	11	0.99
PVC-F	Geocomposite	6i	27	1.1	5	1.00	6j	22	4.7	6	1.00
CSPE-R	Granular Soil	7a	36	0	3	1.00	7b	16	0	3	1.00
CSPE-R	Cohesive Soil	7c	31	5.7	6	0.71	7d	18	0	6	0.99
CSPE-R	NW-NP GT	7e	14	0	6	0.97	7f	10	0	6	0.98
CSPE-R	NW-HB GT	7g	21	0	3	1.00	7h	10	0	3	1.00
CSPE-R	Woven GT	7i	11	0	6	0.92	7j	11	0	3	1.00
CSPE-R	Geonet	7k	28	0	9	0.87	7l	16	0	9	0.80
NW-NP GT	Granular Soil	8a	33	0	290	0.97	8b	33	0	117	0.96
NW-HB GT	Granular Soil	8c	28	0	6	0.99	8d	16	0	6	0.91
Woven GT	Granular Soil	8e	32	0	81	0.99	8f	29	0	28	0.98
NW-NP GT	Cohesive Soil	9a	30	5	79	0.96	9b	21	0	28	0.79
NW-HB GT	Cohesive Soil	9c	29	0.9	15	0.71	9d	10	0	15	0.83
Woven GT	Cohesive Soil	9e	29	0	34	0.94	9f	19	0	16	0.86
GCL Reinforced (internal)	N/A	10a	16	38	406	0.85	10b	6	12	182	0.91
GCL (NW-NP GT)	HDPE-T	11a	23	8	180	0.95	11b	13	0	157	0.90
GCL (W-SF GT)	HDPE-T	11c	18	11	196	0.96	11d	12	0	153	0.92
Geonet	NW-NP GT	12a	23	0	52	0.97	12b	16	0	32	0.97
Geocomposite (NW-NP GT)	Granular Soil	13a	27	14	14	0.86	13b	21	8	10	0.92

Table 5.26: Linear Best-Fit Line Results for All GCL-Geomembrane Failure Envelopes

Failure Envelope Number	Interface Characteristics				Test Conditions				Peak			Large Displacement		
	Geomembrane Interface Type	Failure Envelope Number	GCL	Geomembrane	SDR (mm/min)	Time of Hydration (hrs)	Time of Consolidation (hrs)	Normal Stress Range (kPa)	Friction Angle (Degrees)	Intercept Value (kPa)	R^2 Value	Friction Angle (Degrees)	Intercept Value (kPa)	R^2 Value
1	Textured HDPE	TH 1	K	60-mil u	1.000	0	0	69-345	25.1	23.96	0.9958	11.6	49.76	0.7500
2		TH 2	K	60-mil u	1.000	48	0	241-965	27.0	1.03	0.9951	17.1	1.72	0.9843
3		TH 3a	C	40-mil t	1.000	0	0	16-670	21.8	13.88	0.9950	9.9	12.83	0.9713
4		TH 3b	C	60-mil t	1.000	1	0	20-62	20.9	1.21	0.9992	15.8	1.14	0.9988
5		TH 4a	C	60-mil t	1.000	24	0	34-138	23.3	0.00	0.9995	16.2	1.03	0.9964
6		TH 4b	C	60-mil t	0.200	24	0	9.6-335	18.3	7.92	0.9889	13.1	4.86	0.9881
7		TH 4c	C	60-mil t	0.025	24	0	34-138	22.6	0.00	0.9978	18.2	0.00	0.9991
8		TH 5	C	80-mil t	0.100	168	48	34-310	17.9	3.74	0.9929	10.4	3.30	0.9792
9		TH 6	A	80-mil s	1.000	0	0	241-965	25.3	45.51	0.9609	16.8	6.55	0.9946
10		TH 7a	A	60/80-mil v	1.000	24	0	6.9-689	20.7	5.83	0.9705	11.0	6.71	0.9965
11		TH 7b	A	60/80-mil s	1.000	24	0	6.9-483	17.6	9.73	0.8834	10.5	6.08	0.3809
12		TH 7c	A	80-mil w	1.000	24	0	38-345	19.9	14.11	0.9356	8.2	11.98	0.9944
13		TH 8a	A	60-mil u	1.000	48	0	51-103	18.2	8.27	0.9999	16.7	3.10	0.9985
14		TH 8b	A	80-mil w	1.000	48	0	89-276	12.8	11.77	0.9319	6.4	12.84	0.9828
15		TH 8c	A	60-mil s	1.000	48	0	51-345	12.2	16.39	0.8606	8.4	6.65	0.8848
16		TH 9a	A	60-mil u	0.200	24	0	9.6-287	19.4	2.63	0.9923	11.7	4.44	0.9894
17		TH 9b	A	60-mil s	0.100	48	0	68-345	19.3	0.00	0.9994	9.6	6.66	0.9988
18		TH 10a	A	60-mil t	1.000	72	24	172-690	9.4	23.78	0.9993	3.8	23.12	0.9610
19		TH 10b	A	80-mil v	1.000	24	12	138-552	19.7	3.10	0.9970	11.1	12.07	0.9785
20		TH 11	A	80-mil s	0.100	168	48	34-310	20.7	7.43	0.9065	12.3	5.13	0.9294
21		TH 12a	B	60-mil s	1.000	0	0	12-48	23.3	1.60	0.8396	17.7	2.03	0.7606
22		TH 12b	B	60-mil t	1.000	0	0	2.4-48	31.2	1.29	0.9950	22.5	1.73	0.9852
23		TH 13a	B	40/60-mil t	1.000	24	0	2.4-103	17.9	3.93	0.8810	9.8	4.13	0.7965
24		TH 13b	B	60-mil s	1.000	24	0	68-690	10.4	12.32	0.9132	7.7	6.66	0.9619
25		TH 14	B	40/60-mil s	1.000	48	0	6.9-48	19.3	0.38	0.9728	12.0	1.81	0.9441
26		TH 15	B	80-mil s	0.100	168	48	34-310	9.8	9.16	0.9608	7.3	8.67	0.9631
27	TVLDPE	TV 1a	G	40-mil u	1.000	24	0	2.4-19.2	33.2	4.15	0.9967	24.2	2.61	0.9761
28		TV 1b	B	60-mil t	1.000	24	0	2.4-48	30.3	2.46	0.9892	23.5	1.66	0.9869
29		TV 2	B	60-mil u	1.000	48	0	12-48	18.6	4.67	0.9956	11.3	5.51	0.9709
30		TV 3a	B (Amoco)	60-mil u	1.000	0	0	12-48	31.2	-0.96	0.9888	24.7	-0.72	0.9944
31		TV 3b	B (Clem)	60-mil u	1.000	0	0	12-48	32.7	2.51	0.9999	27.4	1.80	0.9998
32	TLLDPE	TL 1a	C	40-mil u	1.000	72	0	6.9-55.2	29.3	2.22	0.9996	21.9	2.37	0.9936
33		TL 1b	A	40-mil u	1.000	72	0	6.9-55.2	28.8	2.19	0.9986	23.5	1.17	0.9954
34		TL 2a	C	40-mil t	1.000	72	0	6.9-55.2	27.9	0.12	0.9970	18.3	1.11	0.9997
35		TL 2b	A	40-mil t	1.000	72	0	6.9-55.2	26.3	2.55	0.9987	19.3	1.65	0.9952
36		TL 3	A	40-mil s	1.000	72	48	4.8-19.2	20.6	0.23	0.9979	15.8	0.65	0.9762
37	Smooth HDPE	SH 1a	B	60-mil t	1.000	24	0	2.4-48	11.1	0.53	0.9967	11.1	0.53	0.9967
38		SH 1b	C	60-mil t	1.000	48	0	10-69	8.8	0.90	0.9954	8.8	0.90	0.9954
39		SH 2a	B	60-mil u	0.200	24	0	9.6-287	9.2	3.94	0.9866	9.2	2.86	0.9871
40		SH 2b	C	60-mil t	0.200	24	0	9.7-290	8.6	3.62	0.9760	8.0	2.44	0.9830
41	Smooth VLDPE	SV 1	B	40-mil u	1.000	24	0	2.4-19.2	14.1	0.40	0.9909	14.1	0.40	0.9909
42		SV 2	A	40-mil s	1.000	24	0	14.4-23.9	14.0	0.24	1.0000	14.0	0.24	1.0000
43	Smooth	SL 1	A	60-mil u	1.000	24	0	13.8-34.5	13.1	0.57	0.9423	13.1	-0.11	0.9423
44	LLDPE	SL 2	F	40-mil	1.000	168	0	13.8-55.2	12.1	0.69	0.9967	12.1	0.69	0.9967
45	PVC	PVC 1a	A	30-mil x (Smooth)	1.000	24	0	13.8-41	16.7	1.66	0.9908	16.7	1.66	0.9908
46		PVC 1b	A	40-mil y (Faille)	1.000	48	0	4.8-24	18.5	0.18	0.9997	18.5	0.18	0.9997
47		PVC 1c	A	40-mil z (Smooth)	0.050	24	48	2.4-36	15.9	0.65	0.9993	15.9	0.65	0.9993
48	Pavlik (1997)	P 1	B	60- mil THDPE	1.000	48	0	7-28	18.3	5.90	0.9990	9.9	4.35	0.9485
49	Triplett and Fox (2001)	TF 1	A	40-mil t (Smooth)	0.100	48	0	6.9-279	9.8	0.35	1.0000	7.1	1.41	0.9988
50		TF 2	A	40-mil t (Textured)	0.100	48	0	6.9-280	14.9	10.57	0.9846	8.0	6.19	0.9737
51		TF 3	A	40-mil s (Textured)	0.100	48	0	6.9-281	23.6	-2.24	0.9844	12.0	1.16	0.9904

CALCULATION SHEET

Computed: MRL Date: 10/2/18 Checked: RCM Date: 10/2/18	KEY ENVIRONMENTAL INCORPORATED	Client: Earth Systems Project No.: 18626 02 Task: Design Page 1 of 5

Subject: Geotextile Separation Design

Purpose: Determine geotextile properties for separation applications for the No 1 Landfarm Cap:

1) between coarse aggregate cover and common fill; and,
2) between edge aggregate at toe and common fill.

Solution:

(A) common fill. Assume < 50 % passing No. 200 sieve

from Koerner 6th Edition $O_{95} \leq 0.60$ mm = 0.024 inch

AOS ≥ No. 30 sieve

(B) Coarse Aggregate. No. 2 or No. 3 NJDOT size (up to 3")
placed on prepared common fill.

based on GRI GT13(a) Table 3 → Class 2 geotextile
use Table 1(b) spec.

(C) Edge Aggregate. No. 1 NJDOT size (up to 4")
placed on existing grade in thin layer.

based on GRI GT13(a) Table 3 → use Class 1 geotextile
use Table 1(a) spec.

geotextile's permeability to be some multiple of the adjacent soil's permeability—e.g., 0.1, 1.0 or 10.0 (see Christopher and Fisher [3]).

Soil Retention. For the required flow of liquid to be allowed through the geotextile, the void spaces in it must be sufficiently large. There is, however, a limit—that being when the upstream soil particles start to pass through the geotextile voids along with the flowing liquid. This can lead to an unacceptable situation called *soil piping*, in which soil particles are carried through the geotextile, leaving unstable soil voids behind. The velocity of the liquid then increases, accelerating the process, until the upstream soil structure begins to collapse. This collapse often leads to small sinkhole-type patterns that grow larger with time.

This process is prevented by making the geotextile voids tight enough to retain the soil on the upstream side of the fabric. It is the coarser soil fraction that must be initially retained and that is the targeted soil size in the design process. These coarser-sized particles eventually block the finer-sized particles from moving and build up a stable upstream soil structure. In a sense, the geotextile is acting as a catalyst to make the upstream soil do its own filtration. Fortunately, filtration concepts are well established in the design of soil filters, and those same ideas will be used to design an adequate geotextile filter.

There are many formulas that can be applied to soil-retention design, most of which use the soil particle size characteristics and compare them to the 95% opening size of the geotextile, which is defined as the O_{95} value. The test method used in the United States to determine this value is called the *apparent opening size* (AOS) and is obtained using a dry-sieving method. In Europe and Canada, the test method is called *filtration opening size* (FOS) and is accomplished by wet or hydrodynamic sieving. Both of these latter methods are preferable to the dry-sieving method used in the United States, but there seems to be a reluctance to change.

The simplest of the design procedures examines the percentage of soil passing the no. 200 sieve, whose openings are 0.074 mm. According to AASHTO [4], the following is recommended:

- For soil with ≤ 50% passing the no. 200 sieve: $O_{95} < 0.60$ mm—i.e., AOS of the fabric ≥ no. 30 sieve.
- For soil > 50% passing the no. 200 sieve: $O_{95} < 0.30$ mm—i.e., AOS of the fabric ≥ no. 50 sieve

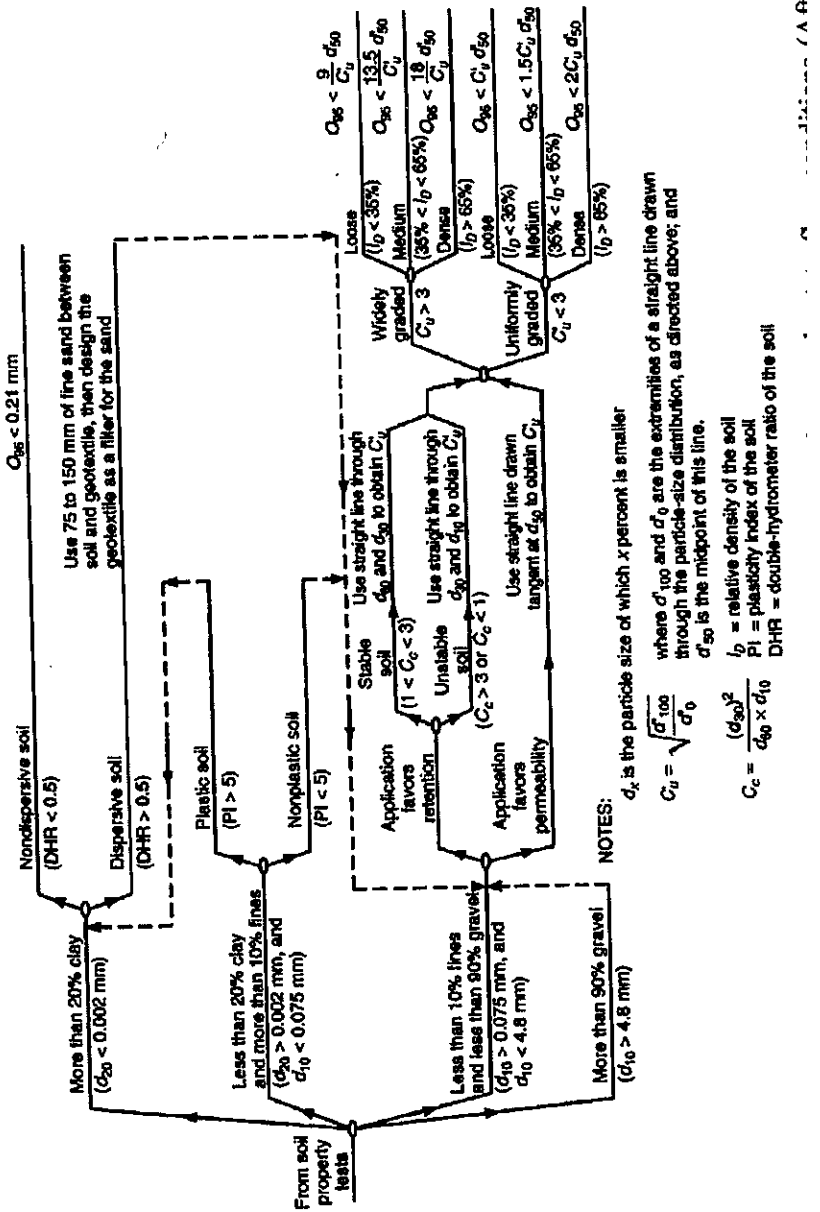


Table 901.03-1 Standard Sizes of Coarse Aggregate

		Amounts finer than each laboratory sieve, percentage by weight														
No.	Nominal Size	4"	3-1/2"	3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No. 50	No. 100
1	3-1/2" - 1-1/2"	100	90-100		25-60		0-15		0-5							
2	2-1/2" - 1-1/2"			100	90-100	35-70	0-15		0-5							
3	2" - 1"				100	90-100	35-70	0-15		0-5						
4	1-1/2" - 3/4"					100	90-100	20-55	0-15		0-5					
5	1" - 1/2"						100	90-100	20-55	0-10	0-5					
57	1" - No. 4						100	95-100		25-60		0-10	0-5			
67	3/4" - No. 4							100	90-100		20-55	0-10	0-5			
7	1/2" - No. 4								100	90-100	40-70	0-15	0-5			
8	3/8" - No. 8									100	85-100	10-30	0-10	0-5		
9	No. 4 - No. 16										100	85-100	10-40	0-10	0-5	
10	No. 4 - No. 200										100	85-100				10-30

Table 901.03-2 Coarse Aggregate Sampling

Coarse Aggregate, No.	Sample Size (pounds)	Frequency
1	150	1000 tons or 830 cubic yards
2	100	1000 tons or 830 cubic yards
3	90	1000 tons or 830 cubic yards
4	70	1000 tons or 830 cubic yards
5 & 57	50	500 tons or 415 cubic yards
67	30	500 tons or 415 cubic yards
7	20	250 tons or 200 cubic yards
8, 9, & 10 (stone sand)	10	250 tons or 200 cubic yards

901.03.01 Broken Stone

Use broken stone that is uniform in texture and quality and that conforms to the requirements specified in Table 901.03.01-1.

Table 901.03.01-1 Requirements for Broken Stone

Aggregate Property	Test Method	Maximum Percent
Weathered and deleterious stone	NJDOT A-3	5
Broken stone other than that classification approved for use	NJDOT A-3	5
Flat and elongated pieces for graded material No. 67 and larger (length greater than 5 times the thickness or width)	ASTM D 4791	10
Absorption in cold water:		
No. 9 and larger	AASHTO T 85	1.8
Stone sand only (No. 10)	AASHTO T 84	2.0
Sodium sulfate soundness, loss	AASHTO T 104	10
Adherent fines in coarse aggregates:		
HMA	NJDOT A-4	1.5
Concrete	NJDOT A-4	1.0
Percentage of wear (Los Angeles Abrasion Test):		
HMA surface course	AASHTO T 96	40
HMA intermediate or base course	AASHTO T 96	45
Concrete surface course and bridge decks	AASHTO T 96	40
Concrete, other	AASHTO T 96	50
Dense-graded aggregate base course	AASHTO T 96	50

Table 3 - Required Degree of Survivability as a Function of Subgrade Conditions, Construction Equipment and Lift Thickness
(Class 1, 2 and 3 Properties are Given in Table 1 and 2; Class 1 + Properties are Higher than Class 1 but Not Defined at this Time)

	Low ground-pressure equipment ≤ 25 kPa (3.6 psi)	Medium ground-pressure equipment > 25 to ≤ 50 kPa (>3.6 to ≤ 7.3 psi)	High ground-pressure equipment > 50 kPa (> 7.3 psi)
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 450 mm (18 in.) in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 450 mm (18 in.) in depth or height. Larger depressions should be filled.	Moderate (Class 2)	High (Class 1)	Very High (Class 1+)
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than ± 150 mm (6 in.) above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High (Class 1)	Very high (Class 1+)	Not recommended

*Recommendations are for 150 to 300 mm (6 to 12 in.) initial lift thickness. For other initial lift thicknesses:
300 to 450 mm (12 to 18 in.): reduce survivability requirement one level;
450 to 600 mm (18 to 24 in.): reduce survivability requirement two levels;
> 600 mm (24 in.): reduce survivability requirement three levels

Note 1: While separation occurs in every geotextile application, this pavement-related specification focuses on subgrade soils being "firm" as indicated by CBR values higher than 3.0 (soaked) or 8.0 (unsoaked).

Source: Modified after Christopher, Holtz, and DiMaggio

English Units

Table 1(a) – Geotextile Properties Class 1 (High Survivability)

← for NJDOT No. 1 coarse aggregate

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D 4632	lb	315	203
Trapezoid Tear Strength	D 4533	lb	112	79
CBR Puncture Strength	D 6241	lb	630	440
Permittivity	D 4491	sec-1	0.02	0.02
Apparent Opening Size	D 4751	in.	0.024	0.024
Ultraviolet Stability[2]	D 7238	% Str. Ret. @ 500 lt. hrs.	80	80

Table 1(b) – Geotextile Properties Class 2 (Moderate Survivability)

← for NJDOT No. 2 or 3 coarse aggregate

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D 4632	lb	248	158
Trapezoid Tear Strength	D 4533	lb	90	56
CBR Puncture Strength	D 6241	lb	500	320
Permittivity	D 4491	sec-1	0.02	0.02
Apparent Opening Size	D 4751	in.	0.024	0.024
Ultraviolet Stability[2]	D 7238	% Str. Ret. @ 500 lt. hrs.	70	70

Table 1(c) – Geotextile Properties Class 3 (Low Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D 4632	lb	180	113
Trapezoid Tear Strength	D 4533	lb	68	41
CBR Puncture Strength	D 6241	lb	380	230
Permittivity	D 4491	sec-1	0.02	0.02
Apparent Opening Size	D 4751	in.	0.024	0.024
Ultraviolet Stability[2]	D 7238	% Str. Ret. @ 500 lt. hrs.	60	60

Notes:

(1) All values are minimum average roll values (MARV) except AOS which is a maximum average roll value (MaxARV) and UV stability which is a minimum average value.

(2) Evaluation to be on 50 mm strip tensile specimens after 500 hours exposure.

Geosynthetic Research Institute, 2017. GRI GT-13(a) "Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate" (Rev 4). June 20.

Computed: MW Date: 10/25/18
Checked: CAZ Date: 10/29/18

KEY ENVIRONMENTAL INCORPORATED

Client: Earth Systems
Project No.: 18626

Universal Soil Loss
Soil Remedial Action Design
AOC-3: No. 1 Landfarm
Hess Corporation – Former Port Reading Refining Facility
Port Reading, Middlesex County, New Jersey

Problem Statement

Evaluate erosion potential and sediment yields of the No. 1 Landfarm Site Final Cover.

Approach

The average annual soil loss in tons per acre per year is determined using the Revised Universal Soil Loss Equation which is as follows:

$$A = R * K * LS * C * P$$

where:

A = Average Annual Soil Loss (tons/acre/year)
R = Rainfall and Runoff Erosivity Factor
K = Soil Erodibility Factor (tons/acre)
LS = Slope Length and Steepness Factor
C = Cover Management Factor
P = Practice Factor

The USEPA recommends that soil loss be less than 2 tons per acre (ref. 1). If the soil loss is greater than 2 tons per acre, diversion or other erosion control features should be incorporated into the design to limit erosion.

Assumptions

Assume the following values for each of the soil loss equation factors (ref. 2):

R	K	LS		C		P
200	0.05	0.81	(5% slope)	0.02	(crushed stone)	1
200	0.05	4.00	(30% slope)	0.02	(crushed stone)	1

R = 200, Middlesex County, New Jersey, Figure A1-1, attached
K = 0.05 (1)
LS = Table A1-3 attached
Longest length is 230 feet at a 5% slope condition: LS is 0.81
Longest length is 21 feet at slope 3H:1V condition: LS is 4.

C = 0.02, Table A1-4, [crushed stone (1/4" to 1 ½ ") applied at 240 tons/acre]
P = Held at unity to represent no design terraces or contouring

(1) The K value for gravel is not available for grain size of approximately 2". As such, the same value provided for crushed stone cover was used for the erosivity of the coarse aggregate surfaced cap.

Results

A Ton/acre/year	R	K	LS		C		P
0.8	200	0.05	4.00	(30% slope)	0.02	(crushed stone)	1
0.16	200	0.05	0.81	(5% slope)	0.02	(crushed stone)	1

Conclusions

As shown in the above table, the estimated soil loss for the No. 1 Landfarm site (where steepest slopes are 30%) will be less than or equal to USEPA's 2.0 tons/acre criteria based on conservative estimates for the erodibility of coarse aggregate cover.

References

1. U.S. Environmental Protection Agency, 1989. Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Landfills and Surface Impoundments. EPA/530/SW-89/047. July.
2. New Jersey Department of Agriculture – State Soil Conservation Committee, 2017. The Standards for Soil Erosion and Sediment Control in New Jersey (7th edition, January 2014; Revised July 2017). July. https://nj.gov/agriculture/divisions/anr/pdf/2014secappendices.pdf.
3. Key Environmental, Inc., 2018. Design Drawings titled "Soil Remedial Action Design, AOC-3: No. 1 Landfarm, Hess Corporation – Former Port Reading Refining Facility, Port Reading, Middlesex County, New Jersey". October.

FIGURE A1-1

RAINFALL EROSION VALUES "R"

NEW JERSEY MAP

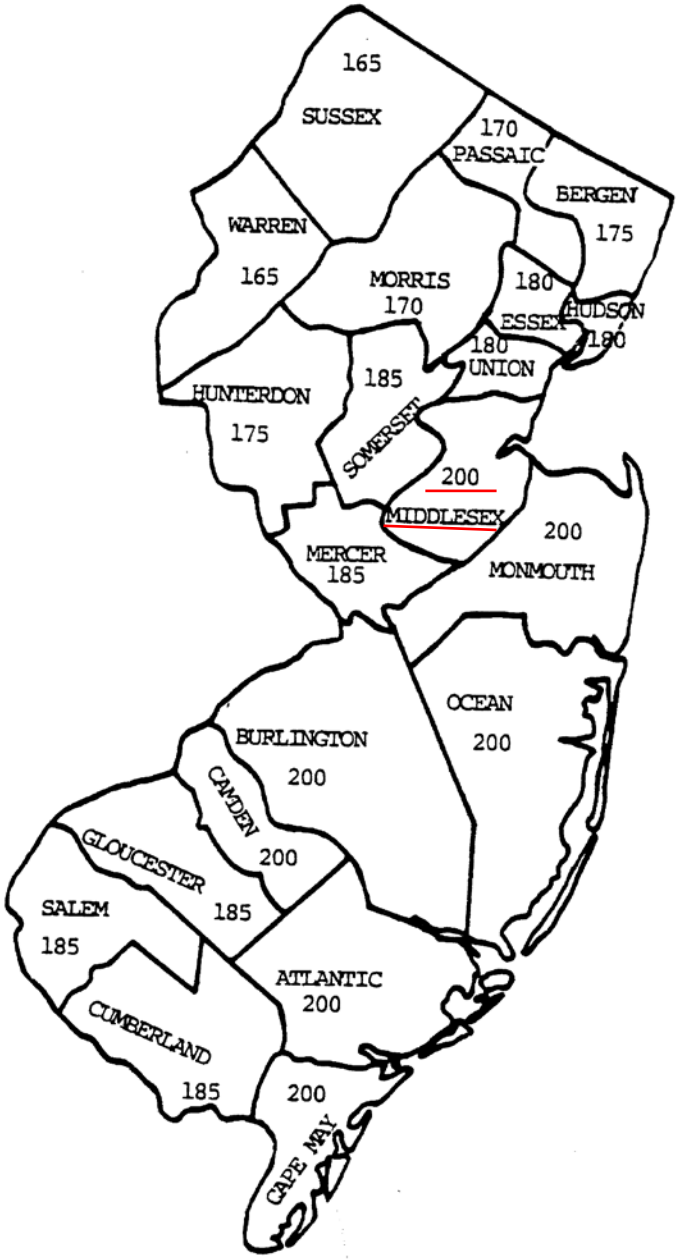


TABLE A1-3

VALUES OF THE TOPOGRAPHIC FACTOR "LS"

Length of Slope (L) Ft.	Percent Slope (S) 0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	25.0	30.0	40.0	50.0	60.0
20	.05	.05	.06	.06	.08	.12	.18	.21	.24	.30	.44	.61	.81	1.0	1.3	1.6	1.8	2.6	4	6	8	10
40	.06	.07	.07	.08	.10	.15	.22	.28	.34	.43	.63	.87	1.2	1.4	1.8	2.2	2.6	3.5	5	8	11	15
60	.07	.08	.08	.08	.11	.17	.25	.33	.41	.52	.77	1.0	1.4	1.8	2.2	2.6	3.0	4.5	6	10	14	18
80	.08	.08	.09	.09	.12	.19	.27	.37	.48	.60	.89	1.2	1.6	2.1	2.6	3.0	3.6	5.5	7	11	16	21
100	.08	.09	.09	.10	.13	.20	.29	.40	.54	.67	.99	1.4	1.8	2.4	2.9	3.5	4.2	6.0	8	13	18	23
110	.08	.09	.10	.10	.13	.21	.30	.42	.56	.71	1.0	1.5	2.0	2.5	3.0	3.7	4.5	6	9	14	19	25
120	.09	.09	.10	.10	.14	.21	.30	.43	.59	.74	1.0	1.6	2.1	2.6	3.3	4.0	4.6	7	9	14	20	26
130	.09	.09	.10	.11	.14	.22	.31	.44	.61	.77	1.2	1.6	2.2	2.8	3.4	4.1	4.9	7	9	15	20	27
140	.09	.10	.10	.11	.14	.22	.32	.46	.63	.80	1.2	1.7	2.3	2.9	3.6	4.3	5.1	7	10	15	21	29
150	.09	.10	.11	.11	.15	.23	.32	.47	.66	.82	1.2	1.8	2.4	3.0	3.7	4.5	5.3	8	10	16	23	30
160	.09	.10	.11	.11	.15	.23	.33	.48	.68	.85	1.2	1.9	2.5	3.1	3.9	4.7	5.5	8	10	17	24	31
180	.10	.10	.11	.12	.15	.24	.34	.51	.72	.90	1.4	1.9	2.6	3.3	4.1	5.0	6.0	9	12	18	26	33
200	.10	.11	.11	.12	.16	.25	.35	.53	.76	.95	1.4	2.1	2.8	3.6	4.4	5.3	6.3	9	12	18	27	35
300	.11	.12	.13	.14	.18	.28	.40	.62	.93	1.2	1.8	2.7	3.6	4.5	5.6	6.8	8	12	16	25	35	45
400	.12	.13	.14	.15	.20	.31	.44	.70	1.0	1.4	2.0	3.2	4.2	5.4	6.7	8.0	10	14	19	30	42	54
500	.13	.14	.15	.16	.21	.33	.47	.76	1.2	1.6	2.2	3.7	4.9	6.2	7.6	9.2	11	16	21	34	47	61
600	.14	.15	.16	.17	.22	.34	.49	.82	1.4	1.6	2.4	4.1	5.4	6.9	8.5	10.3	12	16	24	38	53	68
700	.15	.16	.17	.18	.23	.36	.52	.87	1.4	1.8	2.6	4.5	5.0	7.5	9.3	11.3	13	18	26	41	58	75
800	.15	.16	.17	.18	.24	.38	.54	.92	1.6	2.0	2.8	4.9	6.4	8.2	10.1	12.2	14	20	28	45	58	81
900	.16	.17	.18	.19	.25	.39	.56	.96	1.6	2.0	3.0	5.2	6.9	8.8	10.8	13.1	16	22	30	48	67	87
1000	.16	.18	.19	.20	.26	.40	.57	1.0	1.6	2.2	3.0	5.6	7.4	9.3	11.6	14.0	17	24	32	51	72	93

When the length of slope exceeds 400 feet and (or) percent of slope exceeds 24 percent, soil loss estimates are speculative as these values are beyond the range of research data.

Return to TOC

Table A1-4

C Values and Slope-Length Limits for Various Mulches \1

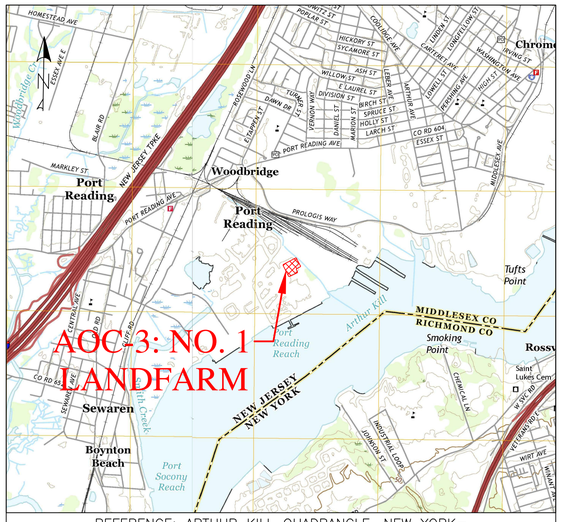
Type	T/ac	Slope %	C Value	Max Length
1. No Mulch or Seeding	---	All	1.0	---
2. Straw or Hay tied	1.0	≤5	. .20	200
		6-10	.20	100
	1.5	≤5	.12	300
		6-10	.12	150
	2.0	≤5	.06	400
		6-10	.06	200
		11-15	.07	150
		16-20	.11	100
		21-25	.14	75
		26-33	.17	50
		34-50	.20	35
3. Crushed Stone (1/4"-1 1/2")	135	≤15	.05	200
		16-20	.05	150
		21-33	.05	100
		34-50	.05	75
	240	≤20	.02	300
		21-33	.02	200
		34-50	.02	150
4. Woodchips	7	≤15	.08	75
		16-20	.08	50
	12	≤15	.05	150
		16-20	.05	100
		21-33	.05	75
	25	≤15	.02	200
		16-20	.02	150
		21-33	.02	100
		34-50	.02	75

APPENDIX C

DESIGN DRAWINGS

EARTH SYSTEMS, INC.

SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION-FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

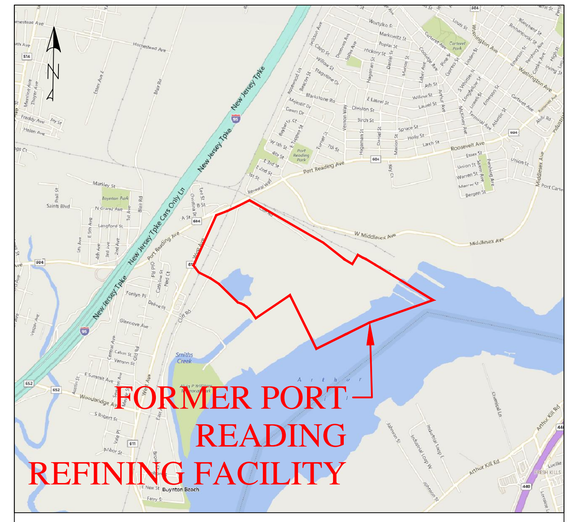


REFERENCE: ARTHUR KILL QUADRANGLE, NEW YORK–NEW JERSEY, 7.5 MINUTE SERIES, USGS, 2016

0 2000 4000 FEET

LOCATION MAP

DRAWING N0.	DRAWING TITLE
LF1-G-001	TITLE SHEET
LF1-G-002	GENERAL NOTES AND LEGEND
LF1-G-003	SOIL EROSION AND SEDIMENT CONTROL NOTES
LF1-C-101	EXISTING SITE CONDITIONS PLAN
LF1-C-102	SOIL EROSION AND SEDIMENT CONTROL PLAN AND WORK AREA PLAN
LF1-C-103	SUBGRADE GRADING PLAN
LF1-C-104	FINAL GRADING PLAN
LF1-C-301	CROSS-SECTIONS
LF1-C-501	SOIL EROSION AND SEDIMENT CONTROL DETAILS
LF1-C-502	CAP DETAILS



REFERENCE: GOOGLE EARTH NOVEMBER 5, 2015

0 2000 4000 FEET

VICINITY MAP

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 09/26/18	KEY ENVIRONMENTAL INCORPORATED	
CHKD: MRK	DATE: 10/08/18		
APPD: AEB	DATE: 11/13/18		
SCALE:	AS SHOWN		

SOIL REMEDIAL ACTION DESIGN
AOC–3: NO. 1 LANDFARM
HESS CORPORATION–FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

TITLE SHEET

PROJECT NO: 18–626

LF1–G–001

GENERAL NOTES:

1. THE GENERAL NOTES APPLY TO ALL OF DRAWINGS IN THE DRAWING SET UNLESS OTHERWISE NOTED. NOTES ARE NOT REPEATED THROUGHOUT THE DRAWING SET TO IDENTIFY THE BASIS OF THE SAME INFORMATION.
2. GRID COORDINATES REFERENCE NEW JERSEY STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM (NAD) OF 1983. ELEVATIONS REFERENCE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
3. EXISTING TOPOGRAPHY AND PHYSICAL FEATURE LOCATIONS BASED ON AUGUST 3, 2018 GROUND SURVEY PERFORMED BY DPK CONSULTING, LLC OF PISCATAWAY, NEW JERSEY.
4. AOC–3: NO. 1 LANDFARM LIMITS AND MONITORING WELL LOCATIONS OBTAINED FROM EARTH SYSTEMS. LYSIMETER INFORMATION OBTAINED FROM FIGURE 2 OF DOCUMENT TITLED "WORK PLAN, LAND TREATMENT DEMONSTRATION PROJECT FOR THE RCRA PART B PERMIT APPLICATION" PREPARED BY ADVENT GROUP, INC., BRENTWOOD, TENNESSEE DATED MARCH 1986. LOCATIONS SHOWN ARE APPROXIMATE.
5. SUBSURFACE FEATURE LOCATIONS SHOWN ARE APPROXIMATE AND ARE BASED ON EVIDENCE OBSERVED ON THE SURFACE ONLY AND REVIEW OF REFERENCE DRAWINGS. INDICATED UTILITIES MAY NOT COMPRISE ALL UTILITIES EITHER IN–SERVICE OR ABANDONED.
6. REFERENCE DRAWINGS INDICATING THE ORIGINAL DESIGN CONSIST OF SHEETS TITLED "SITE PLAN", "GRADING PLAN & DETAILS", "LANDFARM SECTIONS & DETAILS", AND "MISCELLANEOUS DETAILS" OF THE "NO. 1 LANDFARM, AMERADA HESS CORPORATION, PORT READING REFINERY" (JOB NO. 6217) DRAWING SET PREPARED BY AWARE CORPORATION, NASHVILLE, TENNESEE AND HOUSTON, TEXAS DATED JANUARY 1985. LEACHATE TREATMENT REFERENCE DRAWINGS INDICATING SYSTEM UPGRADES ARE INCLUDED IN THE REPORT TITLED "LEACHATE TREATMENT SYSTEM UPGRADE ENGINEERING REPORT, AOC–3: NO. 1 LANDFARM" PREPARED BY EARTH SYSTEMS ENVIRONMENTAL ENGINEERING, BELMAR, NEW JERSEY, DATED JANUARY 2017.
7. NO. 1 LANDFARM LIES WHOLLY OUTSIDE OF THE 100–YEAR BASE FLOOD ELEVATION (1–PERCENT ANNUAL CHANCE FLOOD). 100–YEAR BASE FLOOD ELEVATION IS APPROXIMATELY 9 FEET NAVD 88 IN THE VICINITY OF THE SITE BASED ON FLOOD INSURANCE RATE MAP FOR MIDDLESEX COUNTY, NEW JERSEY (ALL JURISDICTIONS), PANEL 86 OF 286, MAP NUMBER 34023C0086F (FEDERAL EMERGENCY MANAGEMENT AGENCY, JULY 6, 2010). NO. 1 LANDFARM LIES WHOLLY WITHIN THE CATEGORY 1 STORM SURGE AREA DEFINED AS LESS THAN 3 FEET ABOVE GROUND BASED ON THE NATIONAL STORM SURGE HAZARD MAPS.
8. FIGURED DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS. CHECK GRAPHIC SCALE BEFORE SCALING DRAWING.
9. LIMIT OF DISTURBANCE INDICATED IN THIS DRAWING SET IS PROVIDED FOR CLARITY ONLY. LIMIT OF DISTURBANCE AND EROSION AND SEDIMENT CONTROL BMPS SHALL BE PROVIDED IN ACCORDANCE WITH THE APPROVED NPDES GENERAL PERMIT PREPARED BY THE CONTRACTOR.
10. NOTIFY NEW JERSEY ONE CALL (800 272–1000 OR 811) NOT LESS THAN THREE BUSINESS DAYS AND NOT MORE THAN 10 BUSINESS DAYS PRIOR TO THE BEGINNING OF THE EXCAVATION OR DEMOLITION. NEW JERSEY IS NOT EXPECTED TO HAVE COMPLETE RECORD OF UTILITIES FOR THE SITE. VERIFY AND MARK UTILITY AND APPURTENANCE LOCATIONS WITHIN THE PROJECT LIMITS PRIOR TO WORK ON–SITE.
11. STAKE THE LOCATION OF EXCAVATION AND DISTURBED AREAS PRIOR TO ACTUAL WORK.
12. ALL VEHICLES EXITING THE SITE SHALL TRAVEL OVER THE CONSTRUCTION ENTRANCE CONSTRUCTED, MAINTAINED AND INSPECTED IN ACCORDANCE WITH THE APPROVED NPDES GENERAL PERMIT. PROVIDE INGRESS/EGRESS CONTROL INTO THE SITE AS PART OF MOBILIZATION ACTIVITIES.
13. PROVIDE PROTECTION FOR EXISTING UTILITIES TO REMAIN IN SERVICE. PROVIDE TEMPORARY SERVICES REQUIRED TO PERFORM WORK.
14. PHASE CLEARING, DISTURBANCE, AND BORROW OPERATIONS TO MINIMIZE EROSION POTENTIAL.
15. MAINTAIN POSITIVE DRAINAGE AT ALL TIMES DURING AND AFTER CONSTRUCTION.
16. MAINTAIN THE FUNCTION AND OPERABILITY OF THE EXISTING CLAY LAYER AND LEACHATE COLLECTION, CONVEYANCE, TREATMENT, AND DISCHARGE SYSTEM CONTINUOUSLY THROUGHOUT IMPLEMENTATION OF THE REMEDIAL ACTION DESIGN AND THEREAFTER. EXISTING SYSTEM CONSISTS OF, BUT IS NOT LIMITED TO THE FOLLOWING: 1 FOOT CLAY LAYER, 1 FOOT SAND LAYER, 6 INCH DIAMETER PERFORATED UNDERDRAIN SYSTEM AND ASSOCIATED CLEANOUTS, 6 INCH DIAMETER SOLID WALL LEACHATE CONVEYANCE PIPING, LANDFARM DRAINAGE SUMP (3 FEET DIAMETER X 40 FEET LONG), 4 FEET DIAMETER CONCRETE SUMP, UPGRADED (ABOVE–GROUND) LEACHATE TREATMENT SYSTEM, AND ASSOCIATED VALVES, VENTS, POWER, INSTRUMENTATION AND CONTROLS. REFER TO ORIGINAL DESIGN DRAWINGS (AWARE, JANUARY 1985) AND LEACHATE TREATMENT UPGRADE DRAWINGS (EARTH SYSTEMS, JANUARY 2017) FOR ADDITIONAL INFORMATION REGARDING THE LEACHATE MANAGEMENT SYSTEM.

ABBREVIATIONS:

&	AND
@	AT
CL	CENTER LINE
°	DEGREES
'	FOOT, FEET
>	GREATER THAN
<	LESS THAN
"	INCH, INCHES
#	NUMBER, POUND
%	PERCENT
+	PLUS
+/–	PLUS OR MINUS
K20	POTASH EQUIVALENT
P205	PHOSPHATE EQUIVALENT
AC	ACRE
AGIP	AT–GRADE INLET PROTECTION
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
AOC	AREA OF CONCERN
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS INTERNATIONAL
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
BGS	BELOW GROUND SURFACE
BMP	BEST MANAGEMENT PRACTICE
BOT	BOTTOM
C TO C	CENTER TO CENTER
CD	CHECK DAM
CEA	CLASSIFICATION EXCEPTION AREA
CFR	CODE OF FEDERAL REGULATIONS
CFS	CUBIC FEET PER SECOND
CI	CONTOUR INTERVAL (WHEN USED FOR GRADING)
CI	CAST IRON (WHEN USED FOR MATERIAL TYPE)
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CM/SEC	CENTIMETERS PER SECOND
CO	CLEAN–OUT
CPP	CORRUGATED POLYETHYLENE PIPE
CY	CUBIC YARD
DET	DETAIL
DI	DUCTILE IRON
DIA	DIAMETER
DIPS	DUCTILE IRON PIPE SIZE
E	EASTING
E&SC	EROSION AND SEDIMENT CONTROL PLAN
ECB	EROSION CONTROL BLANKET
EL, ELEV	ELEVATION
ELB	ELBOW
ELEC	ELECTRIC
EPD	METHYLENE PROPYLENE DIENEPOLYMER
EW	EACH WAY
EXIST	EXISTING
FEMA	FEDERAL EMERGENCY MANAGEMENT AGENCY
fPP–R	FLEXIBLE POLYPROPYLENE–REINFORCED
FL	FILTER LOG

ABBREVIATIONS: CONT'

FPS	FEET PER SECOND
FSCD	FREEHOLD SOIL CONSERVATION DISTRICT
FT	FOOT, FEET
GCL	GEOSYNTHETIC CLAY LINER
GDL	GEOCOMPOSITE DRAINAGE LAYER
GRI	GEOSYNTHETIC RESEARCH INSTITUTE
HDPE	HIGH DENSITY POLYETHYLENE
ID	IDENTIFICATION
ID	INSIDE DIAMETER (WHEN USED WITH CIRCULAR FEATURES)
IN	INCH, INCHES
INV	INVERT
IPS	IRON PIPE SIZE
K	POTASSIUM
LB/FT	POUNDS PER FOOT
LB, LBS	POUND, POUNDS
LF	LINEAR FEET (FOOT)
LF1	NO. 1 LANDFARM
LLDPE	LINEAR LOW DENSITY POLYETHYLENE
LG	LONG
LOD	LIMIT OF DISTURBANCE
MAX	MAXIMUM
mg/kg	MILLIGRAM PER KILOGRAM
MH	MANHOLE
MHHW	MEAN HIGHER HIGH WATER
MHW	MEAN HIGH WATER
MIN	MINIMUM
MLW	MEAN LOW WATER
MLLW	MEAN LOWER LOW WATER
mm	MILLIMETER
MSF	ONE THOUSAND SQUARE FEET
MSL	MEAN SEA LEVEL
N	NORTHING (WHEN USED FOR GRID COORDINATE SYSTEM)
N	NITROGEN (WHEN USED FOR SEEDING MIXTURE TABLES)
NA	NOT APPLICABLE
NAD	NORTH AMERICAN DATUM
NJAC	NEW JERSEY ADMINISTRATIVE CODE
NAVD	NORTH AMERICAN VERTICAL DATUM
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NJDEP	NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
NJDOT	NEW JERSEY DEPARTMENT OF TRANSPORTATION
NJMUTCD	NEW JERSEY MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES
NJSA	NEW JERSEY STATUTES ANNOTATED
NJUPS	NEW JERSEY UTILITIES PROTECTION SERVICE
NOI	NOTICE OF INTENT
NOT	NOTICE OF TERMINATION
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
NRCS	NATURAL RESOURCES CONSERVATION SERVICE
NSA	NATIONAL STONE ASSOCIATION
NTS	NOT TO SCALE
NW	NONWOVEN
NW–P	NONWOVEN NEEDLE PUNCHED
OC	ON CENTER
OHWM	ORDINARY HIGH WATER MARK
OZ/SY	OUNCES PER SQUARE YARD
P	PHOSPHOROUS
PCF	POUNDS PER CUBIC FOOT
PE	POLYETHYLENE
PERF	PERFORATED
PLS	PURE LIVE SEED
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PST	PORTABLE SEDIMENT TANK
PVC	POLYVINYL CHLORIDE
Q	FLOW
QA	QUALITY ASSURANCE
QC	QUALITY CONTROL
RCP	REINFORCED CONCRETE PIPE
RO	ROUGH OPENING
RQD	ROCK QUALITY DESIGNATION
RECP	ROLLED EROSION CONTROL PRODUCT
REV	REVISION
REQD	REQUIRED
RFA	REQUEST FOR AUTHORIZATION
SCA	STABILIZED CONSTRUCTION ACCESS
SCH	SCHEDULE
SDR	STANDARD DIMENSION RATIO
SEC	SECOND
SECT	SECTION
SESC	SOIL EROSION AND SEDIMENT CONTROL
SF	SILT FENCE (WHEN USED ON E&SC DRAWINGS)
SF	SQUARE FOOT (WHEN USED TO INDICATE SURFACE AREA)
SPCS	STATE PLANE COORDINATE SYSTEMS
PP	SPECIES
SQ FT	SQUARE FEET
SS	STAINLESS STEEL
SSF	SUPER SILT FENCE
ST	SEDIMENT TRAP
STL	STEEL
SWPPP	STORMWATER POLLUTION PREVENTION PLAN
SY	SQUARE YARD
T&B	TOP AND BOTTOM
TRM	TURF REINFORCEMENT MAT
TSF	TONS PER SQUARE FOOT
TSOS	TEMPORARY STONE OUTLET PROTECTION
TWA	TREATMENT WORKS APPROVAL
TYP	TYPICAL
USCS	UNIFIED SOIL CLASSIFICATION SYSTEM
UON	UNLESS OTHERWISE NOTED
US	UNITED STATES
USEPA	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
UV	ULTRAVIOLET
VERT	VERTICAL
W	WIDTH
WSE	WATER SURFACE ELEVATION
W/	WITH
W/O	WITHOUT
WO	WHERE OCCURS
WT	WEIGHT
YR	YEAR

ABBREVIATIONS AND SYMBOLS INDICATED ON THIS SHEET ARE FOR REFERENCE ONLY AND DO NOT INDICATE THEIR INCORPORATION IN THE DESIGN.

GENERAL LEGEND:

- EXISTING ELEVATION CONTOUR (1 FT CI)
- AOC LIMITS (APPROX)
- EXISTING CHAIN LINK FENCE
- EXISTING RAILROAD
- EXISTING EDGE OF PAVEMENT
- EXISTING EDGE OF GRAVEL
- EXISTING EDGE WATER
- EXISTING UNDERGROUND ELECTRIC LINE
- EXISTING STORMWATER LINE
- EXISTING LEACHATE COLLECTION SYSTEM
- EXISTING TREATED WATER LINE
- EXISTING SANITARY SEWER LINE
- EXISTING 6" DIA PERFORATED UNDERDRAIN PIPE
- EXISTING 15" DIA HALF–SECTION CONCRETE PIPE DITCH (APPROX)
- EXISTING 6" DIA SOLID WALL PIPE
- CO2 — EXISTING CLEANOUT
- EXISTING MANHOLE
- EXISTING INLET
- EXISTING HEADWALL/ENDWALL
- EXISTING WATER VALVE
- EXISTING BOLLARD
- EXISTING STANDING WATER
- EXISTING DIKE
- L1–1 — EXISTING MONITORING WELL
- LY–5 — EXISTING LYSIMETER
- PROPOSED ELEVATION CONTOUR (1 FT CI)
- EL 19.7 — PROPOSED SPOT ELEVATIONS
- 5.0% — PROPOSED SLOPE AND DIRECTION
- 1+00 — PROPOSED STATION
- PROPOSED SILT FENCE
- LOD — LOD — PROPOSED LIMIT OF DISTURBANCE
- PROPOSED PASSIVE GAS VENT

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 09/26/18
CHKD: MRK	DATE: 10/08/18
APPD: AEB	DATE: 11/13/18
SCALE: AS SHOWN	

KEY ENVIRONMENTAL INCORPORATED

SOIL REMEDIAL ACTION DESIGN
AOC–3: NO. 1 LANDFARM
HESS CORPORATION–FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

GENERAL NOTES AND LEGEND

PROJECT NO: 18–626

LF1–G–002

FREEHOLD SOIL CONSERVATION DISTRICT SOIL EROSION AND SEDIMENT CONTROL NOTES

1. THE FREEHOLD SOIL CONSERVATION DISTRICT SHALL BE NOTIFIED FORTY–EIGHT (48) HOURS IN ADVANCE OF ANY SOIL DISTURBING ACTIVITY.
2. ALL SOIL EROSION AND SEDIMENT CONTROL PRACTICES ARE TO BE INSTALLED PRIOR TO SOIL DISTURBANCE, IN THEIR PROPER SEQUENCE, AND MAINTAINED UNTIL PERMANENT PROTECTION IS ESTABLISHED.
3. ANY CHANGES TO THE CERTIFIED SOIL EROSION AND SEDIMENT CONTROL PLANS WILL REQUIRE THE SUBMISSION OF REVISED SOIL EROSION AND SEDIMENT CONTROL PLANS TO THE DISTRICT FOR RE–CERTIFICATION. THE REVISED PLANS MUST MEET ALL CURRENT STATE SOIL EROSION AND SEDIMENT CONTROL STANDARDS.
4. N.J.S.A 4:24–39 ET. SEQ. REQUIRES THAT NO CERTIFICATES OF OCCUPANCY BE ISSUED BEFORE THE DISTRICT DETERMINES THAT A PROJECT OR PORTION THEREOF IS IN FULL COMPLIANCE WITH THE CERTIFIED PLAN AND STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY AND A REPORT OF COMPLIANCE HAS BEEN ISSUED. UPON WRITTEN REQUEST FROM THE APPLICANT, THE DISTRICT MAY ISSUE A REPORT OF COMPLIANCE WITH CONDITIONS ON A LOT–BY–LOT OR SECTION–BY–SECTION BASIS, PROVIDED THAT THE PROJECT OR PORTION THEREOF IS IN SATISFACTORY COMPLIANCE WITH THE SEQUENCE OF DEVELOPMENT AND TEMPORARY MEASURES FOR SOIL EROSION AND SEDIMENT CONTROL HAVE BEEN IMPLEMENTED, INCLUDING PROVISIONS FOR STABILIZATION AND SITE WORK.
5. ANY DISTURBED AREAS THAT WILL BE LEFT EXPOSED MORE THAN SIXTY (60) DAYS, AND NOT SUBJECT TO CONSTRUCTION TRAFFIC, WILL IMMEDIATELY RECEIVE TEMPORARY SEEDING. IF THE SEASON PREVENTS THE ESTABLISHMENT OF TEMPORARY COVER, THE DISTURBED AREAS WILL BE MULCHED WITH STRAW, OR EQUIVALENT MATERIAL, AT A RATE OF 2 TO 2 ½ TONS PER ACRE, ACCORDING TO THE STANDARD FOR STABILIZATION WITH MULCH ONLY.
6. IMMEDIATELY FOLLOWING INITIAL DISTURBANCE OR ROUGH GRADING, ALL CRITICAL AREAS SUBJECT TO EROSION (I.E. SOIL STOCKPILES, STEEP SLOPES AND ROADWAY EMBANKMENTS) WILL RECEIVE TEMPORARY SEEDING IN COMBINATION WITH STRAW MULCH OR A SUITABLE EQUIVALENT, AND A MULCH ANCHOR, IN ACCORDANCE WITH STATE STANDARDS.
7. A SUB–BASE COURSE WILL BE APPLIED IMMEDIATELY FOLLOWING ROUGH GRADING AND INSTALLATION OF IMPROVEMENTS TO STABILIZE STREETS, ROADS, DRIVEWAYS, AND PARKING AREAS. IN AREAS WHERE NO UTILITIES ARE PRESENT, THE SUB–BASE SHALL BE INSTALLED WITHIN FIFTEEN (15) DAYS OF THE PRELIMINARY GRADING.
8. THE STANDARD FOR STABILIZED CONSTRUCTION ACCESS REQUIRES THE INSTALLATION OF A PAD OF CLEAN, CRUSHED, ONE INCH TO TWO INCH (1" – 2") DIAMETER STONE AT POINTS WHERE TRAFFIC WILL BE ACCESSING THE CONSTRUCTION SITE.
9. DROPPED, SPILLED, OR TRACKED SOIL OUTSIDE THE LIMIT OF DISTURBANCE OR ONTO PUBLIC RIGHT–OF–WAYS WILL BE REMOVED IMMEDIATELY.
10. PERMANENT VEGETATION IS TO BE SEEDED OR SODDED ON ALL EXPOSED AREAS WITHIN TEN (10) DAYS AFTER FINAL GRADING.
11. AT THE TIME THAT SITE PREPARATION FOR PERMANENT VEGETATIVE STABILIZATION IS GOING TO BE ACCOMPLISHED, ANY SOIL THAT WILL NOT PROVIDE A SUITABLE ENVIRONMENT TO SUPPORT ADEQUATE VEGETATIVE GROUND COVER SHALL BE REMOVED OR TREATED IN SUCH A WAY THAT IT WILL PERMANENTLY ADJUST THE SOIL CONDITIONS AND RENDER IT SUITABLE FOR VEGETATIVE GROUND COVER. IF THE REMOVAL OR TREATMENT OF THE SOIL WILL NOT PROVIDE SUITABLE CONDITIONS, NON–VEGETATIVE MEANS OF PERMANENT GROUND STABILIZATION WILL HAVE TO BE EMPLOYED.
12. IN ACCORDANCE WITH THE STANDARD FOR MANAGEMENT OF HIGH ACID PRODUCING SOILS, ANY SOIL HAVING A pH OF 4 OR LESS OR CONTAINING IRON SULFIDES SHALL BE ULTIMATELY PLACED OR BURIED WITH LIMESTONE APPLIED AT THE RATE OF 10 TONS/ACRE, (OR 450 LBS/1,000 SQ FT OF SURFACE AREA) AND COVERED WITH A MINIMUM OF 12" OF SOIL WITH A pH OF 5 OR MORE, OR 24" WHERE TREES OR SHRUBS ARE TO BE PLANTED.
13. CONDUIT OUTLET PROTECTION MUST BE INSTALLED AT ALL REQUIRED OUTFALLS PRIOR TO THE DRAINAGE SYSTEM BECOMING OPERATIONAL.
14. UNFILTERED DEWATERING IS NOT PERMITTED. NECESSARY PRECAUTIONS MUST BE TAKEN DURING ALL DEWATERING OPERATIONS TO MINIMIZE SEDIMENT TRANSFER. ANY DEWATERING METHODS USED MUST BE IN ACCORDANCE WITH THE STANDARD FOR DEWATERING.
15. SHOULD THE CONTROL OF DUST AT THE SITE BE NECESSARY, THE SITE WILL BE SPRINKLED UNTIL THE SURFACE IS WET, TEMPORARY VEGETATIVE COVER SHALL BE ESTABLISHED OR MULCH SHALL BE APPLIED AS REQUIRED BY THE STANDARD FOR DUST CONTROL.
16. STOCKPILE AND STAGING LOCATIONS ESTABLISHED IN THE FIELD SHALL BE PLACED WITHIN THE LIMIT OF DISTURBANCE ACCORDING TO THE CERTIFIED PLAN. STAGING AND STOCKPILES NOT LOCATED WITHIN THE LIMIT OF DISTURBANCE WILL REQUIRE CERTIFICATION OF A REVISED SOIL EROSION AND SEDIMENT CONTROL PLAN. CERTIFICATION OF A NEW SOIL EROSION AND SEDIMENT CONTROL PLAN MAY BE REQUIRED FOR THESE ACTIVITIES IF AN AREA GREATER THAN 5,000 SQUARE FEET IS DISTURBED.
17. ALL SOIL STOCKPILES ARE TO BE TEMPORARILY STABILIZED IN ACCORDANCE WITH SOIL EROSION AND SEDIMENT CONTROL NOTE #6.
18. THE CONTRACTOR BE RESPONSIBLE FOR ANY EROSION OR SEDIMENTATION THAT MAY OCCUR BELOW STORMWATER OUTFALLS OR OFFSITE AS A RESULT OF CONSTRUCTION OF THE PROJECT.

SEQUENCE OF CONSTRUCTION

THE MAJOR CONSTRUCTION ACTIVITIES ASSOCIATED WITH CLOSURE OF LF1 AND THEIR SEQUENCE ARE PRESENTED TO PROVIDE A GENERAL UNDERSTANDING OF CLOSURE ACTIVITY IMPLEMENTATION. THE SEQUENCE OF CONSTRUCTION IS PROVIDED FOR ILLUSTRATIVE PURPOSES AND MAY BE MODIFIED BY THE CONTRACTOR PROVIDED THAT ANY PERMIT CONDITIONS, DESIGN CRITERIA, AND SOIL EROSION, SEDIMENT, AND STORMWATER MANAGEMENT PRACTICES ARE MET. PROPOSED MODIFICATIONS MAY REQUIRE SUBMITTAL TO THE STAKEHOLDER(S) HAVING APPROVAL AUTHORITY. ANY MODIFICATIONS TO THIS SEQUENCE OF CONSTRUCTION SHALL BE SUBMITTED TO ENGINEER FOR REVIEW TO ASCERTAIN IF THE PROJECT REQUIREMENTS HAVE BEEN MET.

1. NOTIFY THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND FREEHOLD SOIL CONSERVATION DISTRICT AT LEAST 7 DAYS PRIOR TO IMPLEMENTING CONSTRUCTION ACTIVITIES. HOLD PRE–CONSTRUCTION MEETING WITH ENGINEER AND THE NJDEP INSPECTOR.
2. INSPECT SITE PRIOR TO CONSTRUCTION TO VERIFY EXISTING SITE CONDITIONS AND UNDERGROUND UTILITY LOCATIONS.
3. ESTABLISH HORIZONTAL AND VERTICAL CONTROL FOR EXCAVATION AND LIMIT OF DISTURBANCE. STAKE THE LOCATIONS OF AREAS TO BE DISTURBED OR EXCAVATED PRIOR TO ACTUAL WORK.
4. INSTALL PERIMETER CONTROLS FOR STABILIZED CONSTRUCTION ACCESS. INSTALL STABILIZED CONSTRUCTION ACCESS.
5. INSTALL REMAINING PERIMETER CONTROLS (E.G. SILT FENCE) PRIOR TO DISTURBING UPGRADIENT AREAS.
6. INSTALL DECONTAMINATION PAD.
7. CLEAR AND GRUB VEGETATIVE MATTER AND MANAGE WITHIN LF1 LIMITS.
8. REMOVE STANDING WATER FROM WITHIN LF1 LIMITS AND MANAGE REMOVED WATER. LOWER LIQUID LEVEL TO A MINIMUM OF 1 FOOT BELOW THE WORK SURFACE AND MANAGE REMOVED WATER. LEACHATE ELEVATION MAY BE LOWERED BY PROVIDING TEMPORARY SUMPS LOCATED WITHIN LF1 LIMITS WITH BOTTOM OF SUMP(S) LOCATED NO DEEPER THAN THE TOP OF THE EXISTING 1 FT THICK CLAY LAYER.
9. INSTALL AND MAINTAIN THROUGHOUT CONSTRUCTION RUN–OFF CONTROL FEATURES TO CONTAIN RUN–OFF TO WITHIN THE LIMITS OF LF1.
10. REMOVE, ABANDON IN–PLACE, OR RETROFIT LF1 FEATURES AS INDICATED.
11. PROOF–ROLL SURFACES TO RECEIVE REGRADED LF1 MATERIAL, AOC–3 RELATED MATERIAL OR COMMON FILL. PLACE, COMPACT, AND TEST MATERIALS AS INDICATED. GRADE SELECT LF1 MATERIAL, AOC–3 RELATED MATERIAL OR COMMON FILL WITHIN LF1 LIMITS TO INDICATED SUBGRADE ELEVATIONS.
12. INSTALL PASSIVE GAS VENTS.
13. CONSTRUCT COARSE AGGREGATE SURFACED CAP.
14. REMOVE ASSOCIATED TEMPORARY EROSION, SEDIMENT AND STORMWATER MANAGEMENT PRACTICES DOWNGRADIENT OF THE "FINAL STABILIZATION" AREA UPON ACHIEVING AND RECEIVING ACCEPTANCE OF "FINAL STABILIZATION".

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

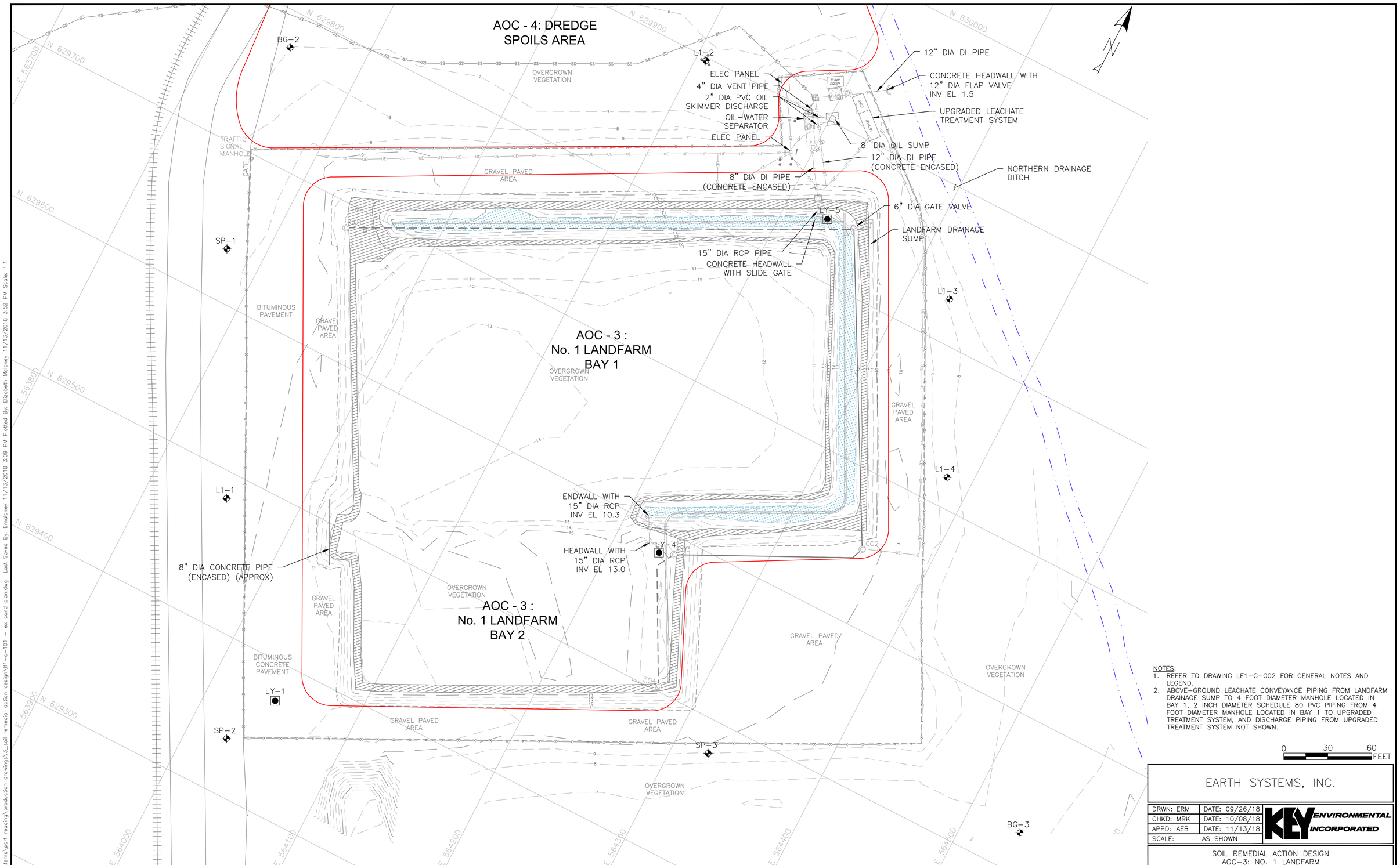
DRWN: ERM	DATE: 09/26/18	KEY ENVIRONMENTAL INCORPORATED
CHKD: MRK	DATE: 10/08/18	
APPD: AEB	DATE: 11/13/18	
SCALE:	AS SHOWN	

SOIL REMEDIAL ACTION DESIGN
AOC–3: NO. 1 LANDFARM
HESS CORPORATION–FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

SOIL EROSION AND SEDIMENT CONTROL NOTES

PROJECT NO: 18–626

LF1–G–003



NOTES:
1. REFER TO DRAWING LF1-G-002 FOR GENERAL NOTES AND LEGEND.
2. ABOVE-GROUND LEACHATE CONVEYANCE PIPING FROM LANDFARM DRAINAGE SUMP TO 4 FOOT DIAMETER MANHOLE LOCATED IN BAY 1, 2 INCH DIAMETER SCHEDULE 80 PVC PIPING FROM 4 FOOT DIAMETER MANHOLE LOCATED IN BAY 1 TO UPGRADED TREATMENT SYSTEM, AND DISCHARGE PIPING FROM UPGRADED TREATMENT SYSTEM NOT SHOWN.

0 30 60 FEET

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 09/26/18
CHKD: MRK	DATE: 10/08/18
APPD: AEB	DATE: 11/13/18
SCALE:	AS SHOWN

KEY ENVIRONMENTAL INCORPORATED

SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION-FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EXISTING SITE CONDITIONS PLAN

PROJECT NO: 18-626

LF1-C-101

AOC - 4: DREDGE SPOILS AREA

BG–2

L1–2

OVERGROWN VEGETATION

ELEC PANEL
4" DIA VENT PIPE
2" DIA PVC OIL SKIMMER DISCHARGE
OIL–WATER SEPARATOR
ELEC PANEL

12" DIA DI PIPE
CONCRETE HEADWALL WITH 12" DIA FLAP VALVE INV EL 1.5
UPGRADED LEACHATE TREATMENT SYSTEM
8' DIA OIL SUMP
12" DIA DI PIPE (CONCRETE ENCASED)
8" DIA DI PIPE (CONCRETE ENCASED)
15" DIA RCP PIPE

1 LF1-C-501 STABILIZED CONSTRUCTION ACCESS

TRAFFIC SIGNAL MANHOLE

GATE

GRAVEL PAVED AREA

LY–5

SP–1

CONCRETE HEADWALL WITH SLIDE GATE

3 LF1-C-501 DECONTAMINATION PAD

BITUMINOUS PAVEMENT

GRAVEL PAVED AREA

L1–3

AOC - 3 : No. 1 LANDFARM BAY 1

OVERGROWN VEGETATION

L1–4

L1–1

ENDWALL WITH 15" DIA RCP INV EL 10.3

HEADWALL WITH 15" DIA RCP INV EL 13.0

LY–4

CO2

OVERGROWN VEGETATION

GRAVEL PAVED AREA

AOC - 3 : No. 1 LANDFARM BAY 2

CONTRACTOR STAGING AREA

GRAVEL PAVED AREA

BITUMINOUS CONCRETE PAVEMENT

OVERGROWN VEGETATION

CO4

LY–1

SP–2

GRAVEL PAVED AREA

GRAVEL PAVED AREA

SP–3

2 LF1-C-501 SILT FENCE

OVERGROWN VEGETATION

BG–3

NOTES:
1. REFER TO DRAWING LF1–G–002 FOR GENERAL NOTES AND LEGEND.
2. REFER TO DRAWING LF1–G–003 FOR SOIL EROSION AND SEDIMENT CONTROL NOTES.

0 30 60 FEET

EARTH SYSTEMS, INC.

DRWN: MRK	DATE: 09/28/18	KEY ENVIRONMENTAL INCORPORATED
CHKD: MRK	DATE: 10/08/18	
APPD: AEB	DATE: 11/13/18	
SCALE: AS SHOWN		

SOIL REMEDIAL ACTION DESIGN
AOC–3: NO. 1 LANDFARM
HESS CORPORATION–FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

REV #	DATE	DESCRIPTION	APPD

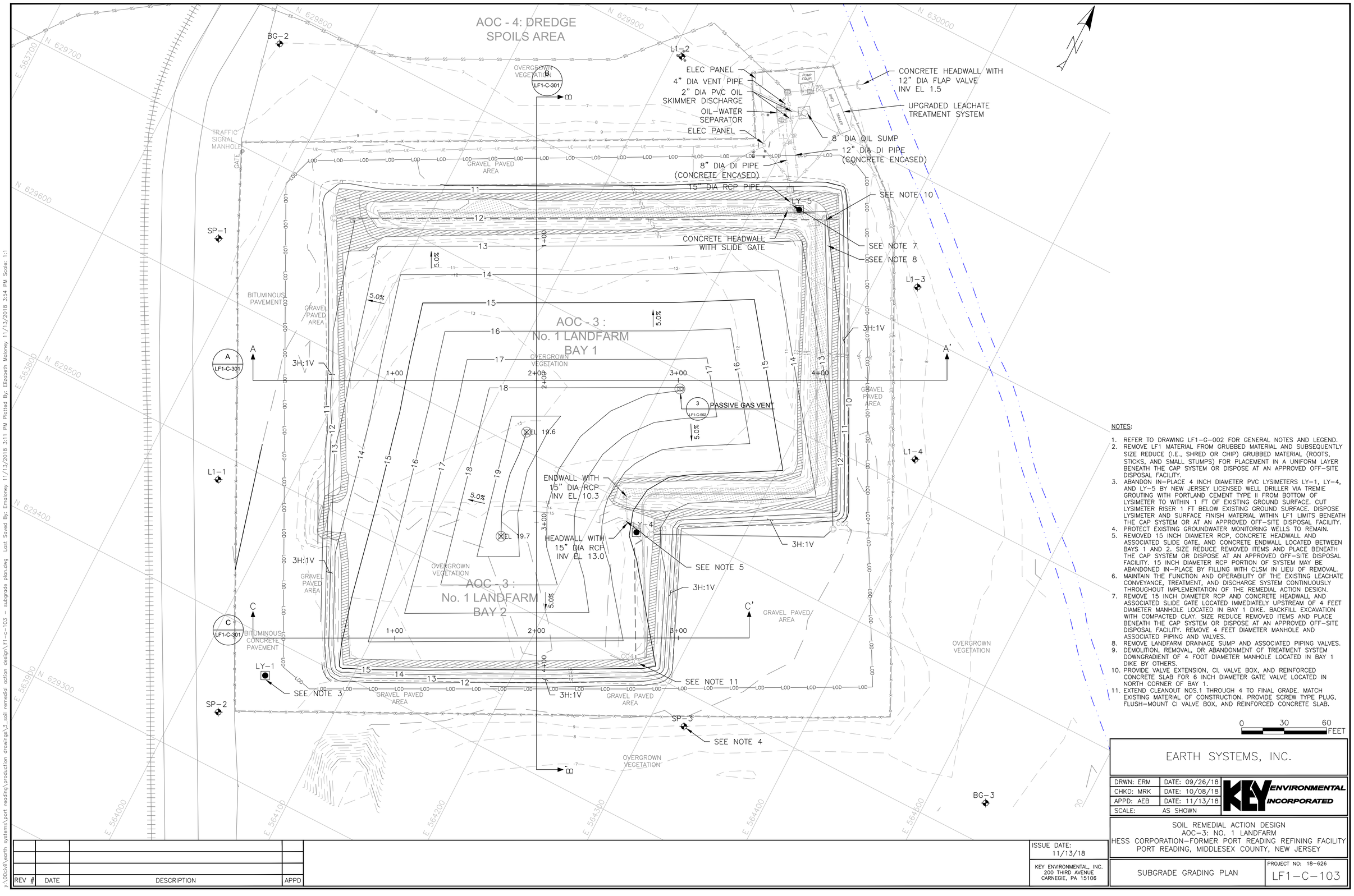
ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

SOIL EROSION AND SEDIMENT CONTROL PLAN AND WORK AREA PLAN

PROJECT NO: 18–626

LF1–C–102



NOTES:

1. REFER TO DRAWING LF1-G-002 FOR GENERAL NOTES AND LEGEND.
2. REMOVE LF1 MATERIAL FROM GRUBBED MATERIAL AND SUBSEQUENTLY SIZE REDUCE (I.E., SHRED OR CHIP) GRUBBED MATERIAL (ROOTS, STICKS, AND SMALL STUMPS) FOR PLACEMENT IN A UNIFORM LAYER BENEATH THE CAP SYSTEM OR DISPOSE AT AN APPROVED OFF-SITE DISPOSAL FACILITY.
3. ABANDON IN-PLACE 4 INCH DIAMETER PVC LYSIMETERS LY-1, LY-4, AND LY-5 BY NEW JERSEY LICENSED WELL DRILLER VIA TREMIE GROUTING WITH PORTLAND CEMENT TYPE II FROM BOTTOM OF LYSIMETER TO WITHIN 1 FT OF EXISTING GROUND SURFACE. CUT LYSIMETER RISER 1 FT BELOW EXISTING GROUND SURFACE. DISPOSE LYSIMETER AND SURFACE FINISH MATERIAL WITHIN LF1 LIMITS BENEATH THE CAP SYSTEM OR AT AN APPROVED OFF-SITE DISPOSAL FACILITY.
4. PROTECT EXISTING GROUNDWATER MONITORING WELLS TO REMAIN.
5. REMOVED 15 INCH DIAMETER RCP, CONCRETE HEADWALL AND ASSOCIATED SLIDE GATE, AND CONCRETE ENDWALL LOCATED BETWEEN BAYS 1 AND 2. SIZE REDUCE REMOVED ITEMS AND PLACE BENEATH THE CAP SYSTEM OR DISPOSE AT AN APPROVED OFF-SITE DISPOSAL FACILITY. 15 INCH DIAMETER RCP PORTION OF SYSTEM MAY BE ABANDONED IN-PLACE BY FILLING WITH CLSM IN LIEU OF REMOVAL.
6. MAINTAIN THE FUNCTION AND OPERABILITY OF THE EXISTING LEACHATE CONVEYANCE, TREATMENT, AND DISCHARGE SYSTEM CONTINUOUSLY THROUGHOUT IMPLEMENTATION OF THE REMEDIAL ACTION DESIGN.
7. REMOVE 15 INCH DIAMETER RCP AND CONCRETE HEADWALL AND ASSOCIATED SLIDE GATE LOCATED IMMEDIATELY UPSTREAM OF 4 FEET DIAMETER MANHOLE LOCATED IN BAY 1 DIKE. BACKFILL EXCAVATION WITH COMPACTED CLAY. SIZE REDUCE REMOVED ITEMS AND PLACE BENEATH THE CAP SYSTEM OR DISPOSE AT AN APPROVED OFF-SITE DISPOSAL FACILITY. REMOVE 4 FEET DIAMETER MANHOLE AND ASSOCIATED PIPING AND VALVES.
8. REMOVE LANDFARM DRAINAGE SUMP AND ASSOCIATED PIPING VALVES.
9. DEMOLITION, REMOVAL, OR ABANDONMENT OF TREATMENT SYSTEM DOWNGRADIENT OF 4 FOOT DIAMETER MANHOLE LOCATED IN BAY 1 DIKE BY OTHERS.
10. PROVIDE VALVE EXTENSION, CI, VALVE BOX, AND REINFORCED CONCRETE SLAB FOR 6 INCH DIAMETER GATE VALVE LOCATED IN NORTH CORNER OF BAY 1.
11. EXTEND CLEANOUT NOS.1 THROUGH 4 TO FINAL GRADE. MATCH EXISTING MATERIAL OF CONSTRUCTION. PROVIDE SCREW TYPE PLUG, FLUSH-MOUNT CI VALVE BOX, AND REINFORCED CONCRETE SLAB.

0 30 60 FEET

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 09/26/18	KEY ENVIRONMENTAL INCORPORATED
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APPD: AEB	DATE: 11/13/18	
SCALE: AS SHOWN		

SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION-FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

SUBGRADE GRADING PLAN

PROJECT NO: 18-626

LF1-C-103

AOC - 4: DREDGE SPOILS AREA

AOC - 3 : No. 1 LANDFARM BAY 1

AOC - 3 : No. 1 LANDFARM BAY 2

CAP TERMINATION 2 LF1-C-502

COARSE AGGREGATE SURFACED CAP 1 LF1-C-502

3 PASSIVE GAS VENT LF1-C-502

EL 21.6

EL 21.7

ENDWALL WITH 15" DIA RCP INV. EL. 10.3

ENDWALL WITH 15" DIA RCP INV. EL. 13.0

CONCRETE HEADWALL WITH SLIDE GATE

CONCRETE HEADWALL WITH 12" DIA FLAP VALVE INV. EL. 1.5

UPGRADED LEACHATE TREATMENT SYSTEM

ELEC PANEL

4" DIA VENT PIPE

2" DIA PVC OIL SKIMMER DISCHARGE

OIL-WATER SEPARATOR

ELEC PANEL

DIA OIL SUMP

8" DIA DI PIPE (CONCRETE ENCASED)

8" DIA DI PIPE (CONCRETE ENCASED)

10" DIA DCP PIPE

OVERGROWN VEGETATION

TRAFFIC SIGNAL MANHOLE

GATE

GRAVEL PAVED AREA

BITUMINOUS PAVEMENT

BITUMINOUS CONCRETE PAVEMENT

5.0%

3H:1V

1+00

2+00

3+00

4+00

BG-1

BG-2

BG-3

L1-1

L1-2

L1-3

L1-4

LY-1

LY-2

LY-3

LY-4

SP-1

SP-2

SP-3

N 629800

N 629900

N 630000

N 629700

N 629600

N 629500

N 629400

N 629300

E 563700

E 563800

E 563900

E 564000

E 564100

E 564200

E 564300

E 564400

E 564500

NOTES:
1. REFER TO DRAWING LF1-G-002 FOR GENERAL NOTES AND LEGEND.

0 30 60 FEET

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
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CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

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KEY ENVIRONMENTAL INCORPORATED

SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION-FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

FINAL GRADING PLAN

PROJECT NO: 18-626

LF1-C-104

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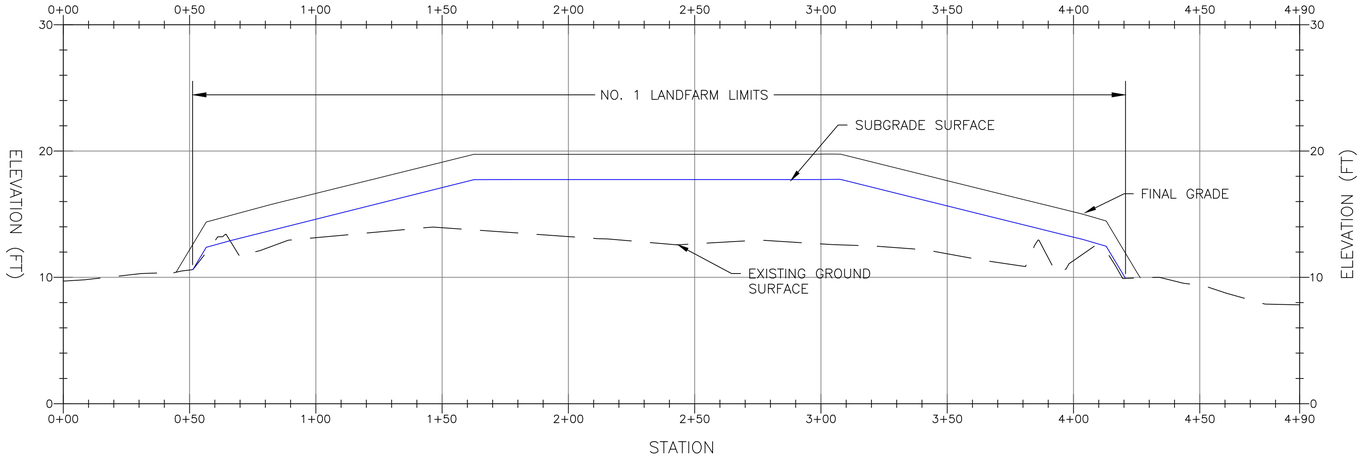
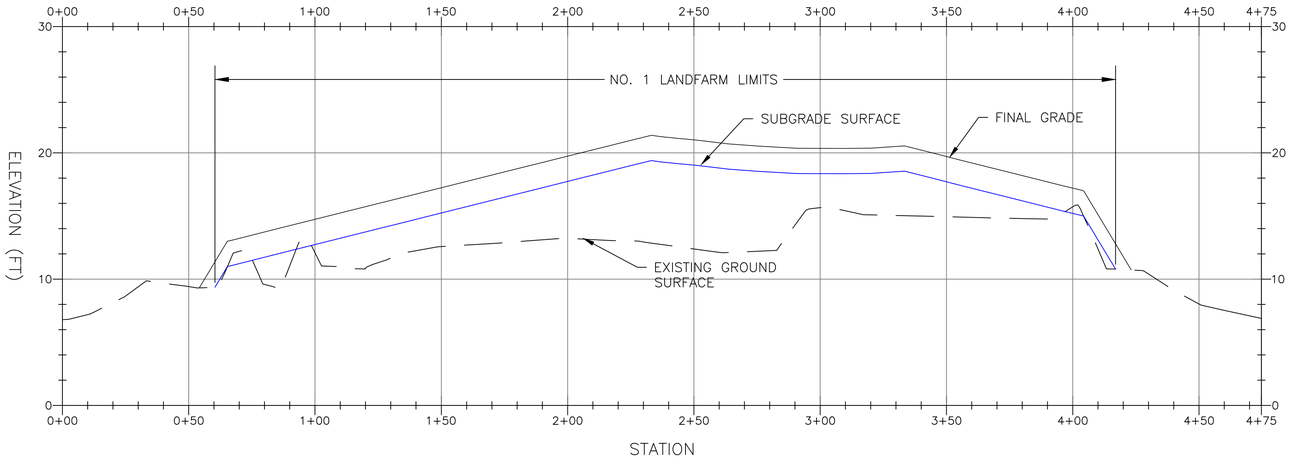
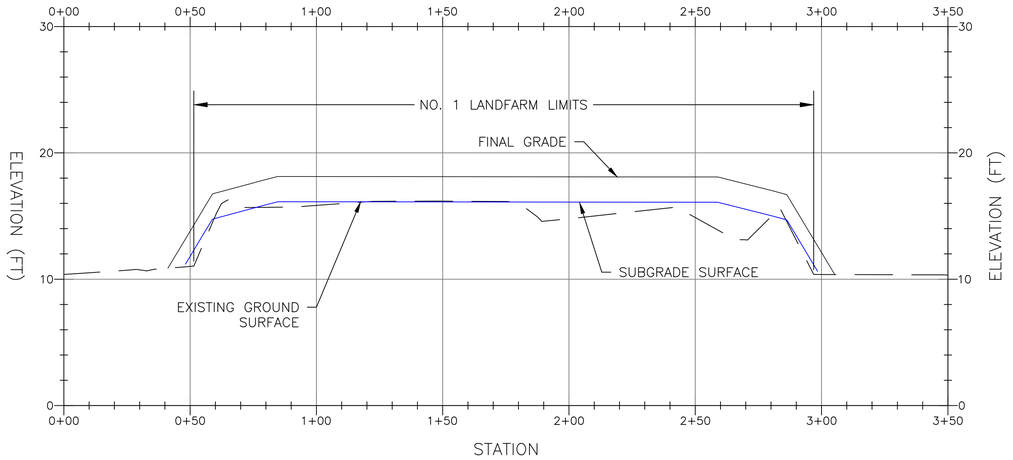


A — LF1-C-301 — CROSS-SECTION A-A'



B — LF1-C-301 — CROSS-SECTION B-B'



C — LF1-C-301 — CROSS-SECTION C-C'

NOTES:

1. REFER TO DRAWING LF1-G-002 FOR GENERAL NOTES AND LEGEND.

V: 0 30 60 FEET

H: 0 30 60 FEET

REV #	DATE	DESCRIPTION	APPD

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CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

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SCALE: AS SHOWN		

SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION-FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

CROSS-SECTIONS

PROJECT NO: 18-626

LF1-C-301

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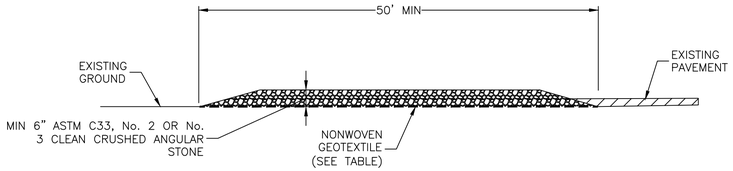
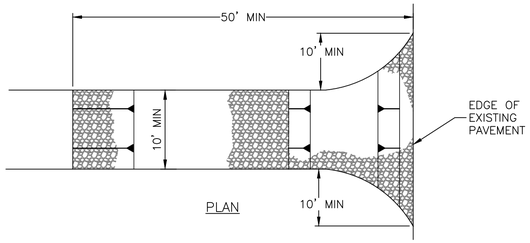


PROFILE



PLAN

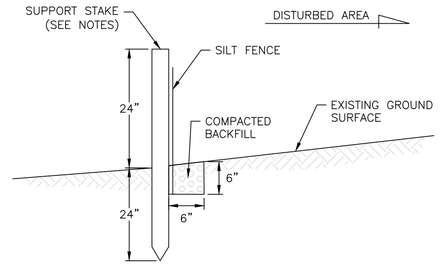
NOTES:

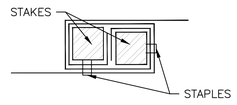
1. INSTALL STABILIZED CONSTRUCTION ACCESS AS SOON AS IS PRACTICABLE BEFORE MAJOR GRADING ACTIVITIES.
2. APPLY TOP DRESSING OF ADDITIONAL AGGREGATE AS CONDITIONS DEMAND. MUD SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC ROADS, OR ANY SURFACE WHERE RUNOFF IS NOT CHECKED BY SEDIMENT CONTROLS, SHALL BE REMOVED IMMEDIATELY. ACCOMPLISH REMOVAL BY SCRAPING OR SWEEPING.
3. ENTRANCE SHALL REMAIN IN PLACE UNTIL THE DISTURBED AREA IS STABILIZED OR REPLACED WITH A PERMANENT ROADWAY OR ENTRANCE.

NONWOVEN GEOTEXTILE PROPERTIES (1)		
PROPERTY	VALUE	ASTM TEST METHOD
GRAB TENSILE STRENGTH	248 LBS	D 4632
CBR PUNCTURE STRENGTH	500 LBS	D 6241
TRAPEZOIDAL TEAR STRENGTH	90 LBS	D 4533
PERMITTIVITY	0.02 SEC−1	D 4491
APPARENT OPENING SIZE	0.024 IN	D 4751
UV STABILITY	70% STRENGTH RETAINED @ 500 LIGHT HRS.	D 7238

(1) PROPERTIES CORRESPOND TO GRI−GT13(A) − ASTM VERSION, "TEST METHODS AND PROPERTIES FOR GEOTEXTILES USED AS SEPARATION BETWEEN SUBGRADE SOIL AND AGGREGATE", TABLE 1 (B) GEOTEXTILE PROPERTIES CLASS 2 (MODERATE SURVIVABILITY), ELONGATION <50%.

1 / LF1-C-501 — STABILIZED CONSTRUCTION ACCESS
NTS



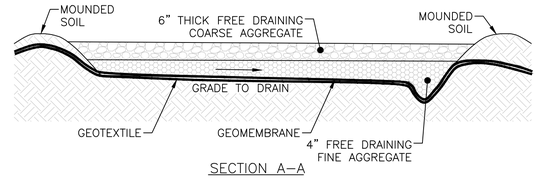


JOINING FENCE SECTIONS

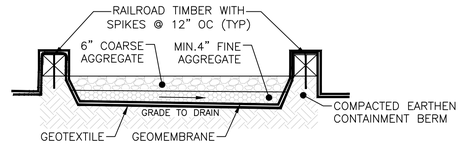
NOTES:

1. STAKES SPACED @ 8' MAXIMUM. USE 2" X 2" WOOD OR EQUIVALENT STEEL STAKES.
2. SILT FENCE MUST BE PLACED AT OR NEAR LEVEL EXISTING GRADE. BOTH ENDS OF THE BARRIER MUST BE EXTENDED AT LEAST 8 FEET UP SLOPE AT 45 DEGREES TO THE MAIN BARRIER ALIGNMENT.
3. SEDIMENT MUST BE REMOVED WHEN ACCUMULATIONS REACH 1/2 THE ABOVEGROUND HEIGHT OF THE FENCE.
4. ANY SECTION OF FILTER FABRIC FENCE WHICH HAS BEEN UNDERMINED OR TOPPED MUST BE IMMEDIATELY REPAIRED.
5. SILT FENCE FABRIC MUST INCORPORATE A DRAWSTRING IN THE TOP PORTION OF THE FENCE FOR ADDED STRENGTH.
6. EMBEDDED COIR FIBER LOGS OR STRAW BALE BARRIER MAY BE USED IN LIEU OF SILT FENCE SUBJECT TO ENGINEER APPROVAL.

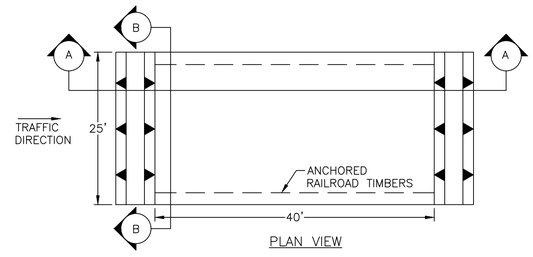
2 / LF1-C-501 — SILT FENCE
NTS



SECTION A−A



SECTION B−B



PLAN VIEW

NOTES:

1. DECONTAMINATION PAD CONSTRUCTED WITHIN LF1 LIMITS DIRECTLY ABOVE LF1 MATERIAL MAY OMIT UNDERLYING GEOMEMBRANE AND GEOTEXTILE AND ALLOW WATER TO DRAIN FREELY. DECONTAMINATION PAD CONSTRUCTED OUTSIDE LF1 LIMITS MUST INCLUDE GEOMEMBRANE AND GEOTEXILE TO PROVIDE CONTAINMENT.
2. PERIODIC INSPECTION AND NEEDED MAINTENANCE SHALL BE PROVIDED AFTER EACH RAIN EVENT.
3. DETAIL IS FOR ILLUSTRATIVE PURPOSES ONLY.

3 / LF1-C-501 — DECONTAMINATION PAD
NTS

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200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

DRWN: MRK	DATE: 09/28/18
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SCALE:	AS SHOWN

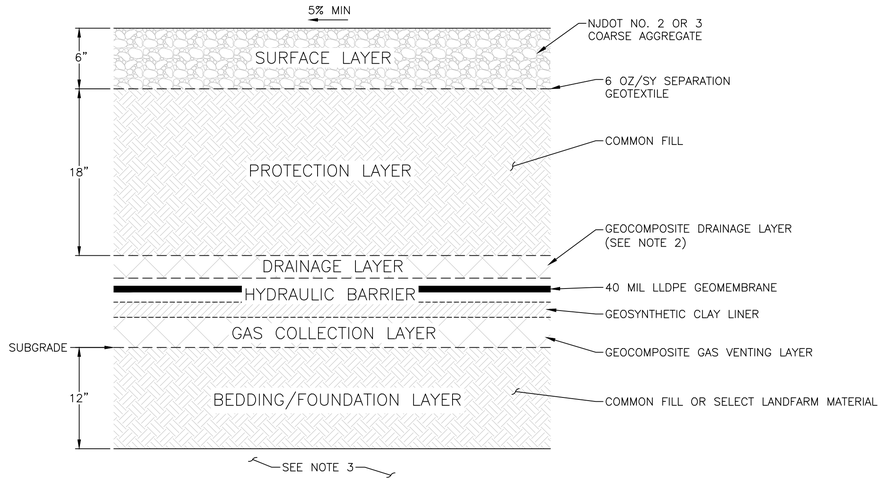
KEY ENVIRONMENTAL INCORPORATED

SOIL REMEDIAL ACTION DESIGN
AOC−3: NO. 1 LANDFARM
HESS CORPORATION−FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

SOIL EROSION AND SEDIMENT CONTROL DETAILS

PROJECT NO: 18−626

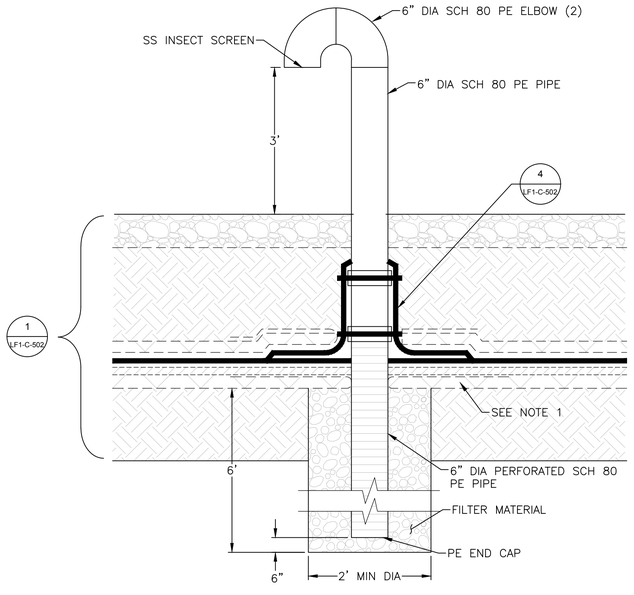
LF1−C−501



1 / LF1-C-502 **COARSE AGGREGATE SURFACED CAP**
NTS

NOTES:

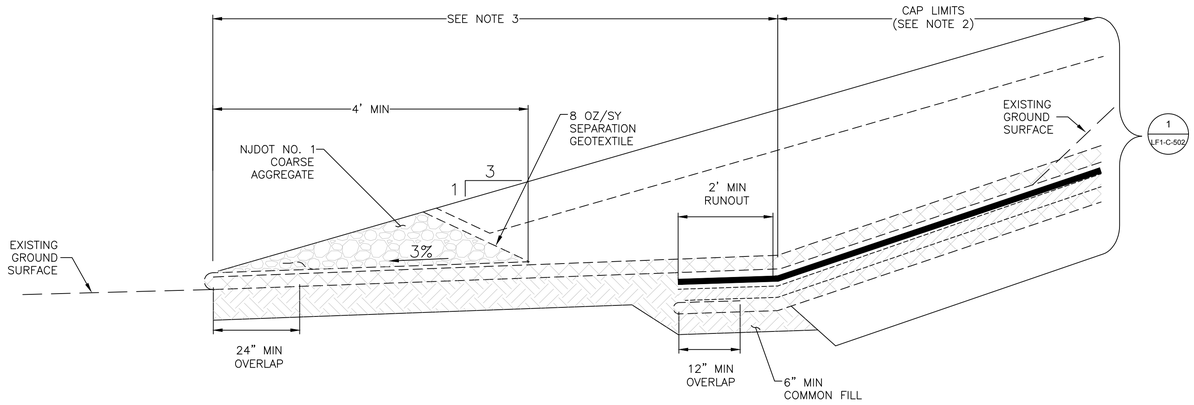
1. PROVIDE SMOOTH OR TEXTURED 40 MIL LLDPE GEOMEMBRANE.
2. PROVIDE DOUBLE-SIDED (SHOWN) OR SINGLE-SIDED GEOCOMPOSITE DRAINAGE LAYER WITHIN CAP LIMITS.
3. LANDFARM MATERIAL, REGRADED LANDFARM MATERIAL, LANDFARM PERIMETER DIKE MATERIAL OR AOC-3 RELATED MATERIAL



3 / LF1-C-502 **PASSIVE GAS VENT**
NTS

NOTES:

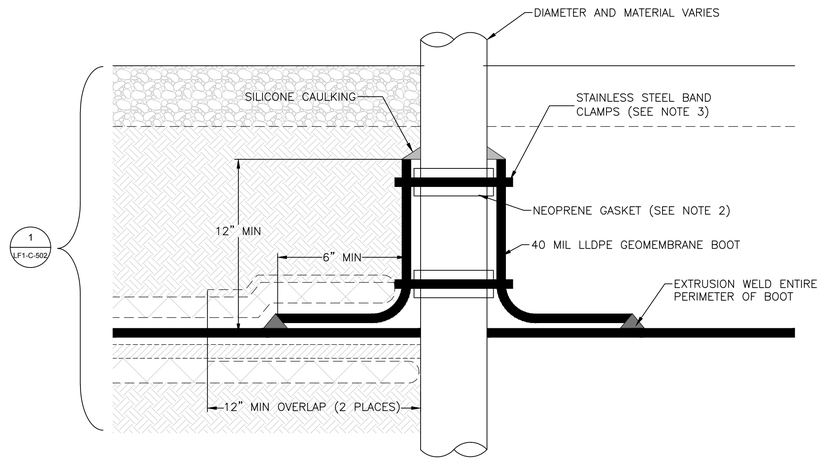
1. PROVIDE ADDITIONAL 6 FOOT MINIMUM WIDTH GEOCOMPOSITE GAS VENTING LAYER (NOT SHOWN) ABOVE SINGLE-SIDED GEOCOMPOSITE GAS VENTING LAYER WITH 6 FOOT DIMENSION CENTERED OVER PEAK OF CAP AND EXTENDING BETWEEN PASSIVE GAS VENTS AND 10 FOOT BEYOND THEIR ENDPOINTS.



2 / LF1-C-502 **CAP TERMINATION**
NTS

NOTES:

1. PROVIDE SMOOTH OR TEXTURED 40 MIL LLDPE GEOMEMBRANE.
2. PROVIDE DOUBLE-SIDED (SHOWN) OR SINGLE-SIDED GEOCOMPOSITE DRAINAGE LAYER WITHIN CAP LIMITS.
3. PROVIDE DOUBLE-SIDED GEOCOMPOSITE DRAINAGE LAYER AT CAP TERMINATION LOCATION BETWEEN GEOCOMPOSITE DRAINAGE LAYER AND COMMON FILL AND AS INDICATED.



4 / LF1-C-502 **GEOMEMBRANE BOOT**
NTS

NOTES:

1. PROVIDE FOR ALL PENETRATIONS THROUGH GEOMEMBRANE. GCL SHALL EXTEND COMPLETELY AROUND PENETRATION.
2. NEOPRENE GASKET TO BE PLACED BETWEEN THE GEOMEMBRANE BOOT AND PENETRATIONS, AND SHALL EXTEND BEYOND THE LOCATIONS OF THE STAINLESS STEEL BAND CLAMPS.
3. LOCATIONS OF STAINLESS STEEL BAND CLAMPS, NEOPRENE GASKET, AND LENGTH OF GEOMEMBANE BOOT MAY NEED TO BE "FIELD FIT".

REV #	DATE	DESCRIPTION	APPD

ISSUE DATE: 11/13/18

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

EARTH SYSTEMS, INC.

DRWN: ERM	DATE: 09/26/18
CHKD: MRK	DATE: 10/08/18
APPD: AEB	DATE: 11/13/18
SCALE:	AS SHOWN

KEY ENVIRONMENTAL INCORPORATED

SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION-FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

CAP DETAILS

PROJECT NO: 18-626

LF1-C-502

APPENDIX D

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS
SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM

HESS CORPORATION
FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

NJDEP PI#006148
ISRA Case No. E20130449
EPA ID No. NJD045445483

Prepared for:

Earth Systems, Inc.
Belmar, New Jersey

Prepared by:

Key Environmental, Inc.
200 Third Avenue
Carnegie, Pennsylvania 15106

November 2018

KEY ENVIRONMENTAL INCORPORATED

PROJECT TABLE OF CONTENTS

DOCUMENT 00 01 15

LIST OF DRAWINGS

PART 1 GENERAL

1.1 SUMMARY

This section lists the drawings for the project.

1.2 REMEDIAL ACTION DESIGN DRAWINGS

Remedial Action Design drawings are as follows:

DRAWING NO.	TITLE	REVISION	DATE
LF1-G-001	Title Sheet	0	11/13/18
LF1-G-002	General Notes and Legend	0	11/13/18
LF1-G-003	Soil Erosion and Sediment Control Notes	0	11/13/18
LF1-C-101	Existing Site Conditions Plan	0	11/13/18
LF1-C-102	Soil Erosion and Sediment Control and Plan and Work Area Plan	0	11/13/18
LF1-C-103	Subgrade Grading Plan	0	11/13/18
LF1-C-104	Final Grading Plan	0	11/13/18
LF1-C-301	Cross-Sections	0	11/13/18
LF1-C-501	Soil Erosion and Sediment Control Details	0	11/13/18
LF1-C-502	Cap Details	0	11/13/18

1.3 SUPPLEMENTARY DRAWINGS

These supplementary drawings may not be a part of the contract but are included with the drawings for information.

1.3.1 Reference Drawings

The following reference drawings are intended only to show the original construction.

DRAWING NO.	TITLE	REVISION	DATE
Document titled ”Leachate Treatment System Upgrade Engineering Report, AOC-3: No. 1 Landfarm, 750 Cliff Road, Port Reading, Middlesex County, New Jersey, NJDEP PI# 006148, ISRA Case No. E20130449, EPA ID No.			

DRAWING NO.	TITLE	REVISION	DATE
NJD045445483." Prepared for Hess Corporation, West Trenton, New Jersey. Prepared by Earth Systems. January 2017.			
Figure 3	Land Farm No. 1 Leachate Treatment P&ID	0	(CAD print date 12/18/17)
Aware Corporation, 1985. Drawing set titled "No. 1 Landfarm, Amerada Hess Corporation, Port Reading Refinery (Job No. 6217)." Prepared for Amerada Hess Corporation. Prepared by Aware Corporation. January 1985.			
1	Site Plan	- -	01/1985
2	Grading Plan & Details	- -	01/1985
3	Landfarm Sections & Details	- -	01/1985
4	Miscellaneous Details	- -	01/1985

1.4 SUPPLEMENTARY REPORTS

The following reference reports are available for examination and are included for information.

1.4.1 Reports

Document titled "No. 1 Landfarm, Technical Specifications, Job No. 6217" prepared for Amerada Hess Corporation, Port Reading Refinery, Port Reading, New Jersey. Prepared by Aware Corporation. January 1985.

1.4.2 Boring Logs

Engineer does not guarantee that borings indicate actual conditions, except for the exact locations and the time that they were made. Subsurface data, not specified or indicated, has been obtained by others. Boring logs are included in Appendix A of the Remedial Action Design Report.

1.4.3 Subsurface Data

Subsurface data, not specified or indicated, have been obtained by Engineer. The data are included in Appendix A of the Remedial Action Design Report.

-- End of Document --

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Project Description

The work includes providing an engineered cap on AOC-3: No. 1 Landfarm, required to meet the closure performance standards specified in the Resource Conservation and Recovery Act and incidental related work.

1.1.2 Location

The work is located at the Hess Corporation - Former Port Reading Refining Facility in Port Reading, Middlesex County, New Jersey, approximately as indicated.

1.2 OCCUPANCY OF PREMISES

Buildings will be occupied and existing Site activities will continue during performance of work under this Contract. Notifications will be posted in a prominent location in the work area.

Before work is started, arrange with the Engineer a sequence of procedure, means of access, space for storage of materials and equipment, and use of approaches and parking.

1.3 EXISTING WORK

The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees and vegetation when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree pruning compound. In addition:

a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.

b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Engineer. At the completion of operations, existing work must be in a condition equal to or better than that which existed before new work started.

1.4 LOCATION OF UNDERGROUND UTILITIES

Obtain permits prior to start of work, and comply with installation requirements for locating and marking underground utilities. Contact New Jersey Call 811 Before You Dig and all pertinent local utility locating services a minimum of 72 hours prior to initiating work, to mark utilities, and within sufficient time required if work occurs on a Monday or after a Holiday. Verify existing utility locations indicated on contract drawings, within area of work.

Identify and mark all other utilities not managed and located by the local utility companies. Scan the construction site with Ground Penetrating Radar (GPR), electromagnetic, or sonic equipment, and mark the surface of the ground or paved surface where existing underground utilities are discovered. Verify the elevations of existing piping, utilities, and any type of underground obstruction not indicated, or specified to be removed, that is indicated or discovered during scanning, in locations to be traversed by piping, ducts, and other work to be conducted or installed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

1.4.1 Notification Prior to Excavation

Notify the Engineer at least 72 hours prior to starting excavation work.

1.5 SALVAGE MATERIAL AND EQUIPMENT

Items designated by the Engineer to be salvaged remain the property of Hess. Segregate, itemize, deliver and off-load the salvaged property as specified by the Engineer. Use a system of property control that is approved by the Engineer. Store and protect salvaged materials and equipment until disposition by the Engineer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 02 56 13

WASTE CONTAINMENT GEOMEMBRANE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1004	(2013) Tear Resistance (Graves Tear) of Plastic Film and Sheeting
ASTM D1238	(2013) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	(2010) Density of Plastics by the Density-Gradient Technique
ASTM D1603	(2014) Carbon Black Content in Olefin Plastics
ASTM D3895	(2014) Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D4218	(2015) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4833	(2007; E 2013; R 2013) Index Puncture Resistance of Geomembranes and Related Products
ASTM D5199	(2012) Measuring the Nominal Thickness of Geosynthetics
ASTM D5321	(2017) Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D5323	(1992; R 2011) Standard Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes
ASTM D5596	(2003; R 2016) Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

ASTM D5617	(2004; R 2015) Standard Test Method for Multi-Axial Tension Test for Geosynthetics
ASTM D5721	(2008; R 2013) Air-Oven Aging of Polyolefin Geomembranes
ASTM D5820	(1995; R 2018) Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D5885	(2017) Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D5994	(2010; R 2015; E2015) Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6370	(2014) Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
ASTM D6392	(2012; R 2018) Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D6497	(2002; R 2015; E 2015) Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures
ASTM D6693	(2004; E 2015) Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
ASTM D7238	(2006; R 2017) Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
ASTM D7466	(2010; E2015) Standard Test Method for Measuring Asperity Height of Textured Geomembranes
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM7	(1995) Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM9	(1995; R 2013) Cold Weather Seaming of Geomembranes

GSI GRI GM17	(2015; Rev 12, 11/4) Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
GSI GRI GM19	(2015) Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
GSI GRI GM20	(2003) Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts

1.2 PANEL LAYOUT

Submit geomembrane panel layout and penetration detail drawings, a minimum of 7 days prior to geomembrane placement.

1.3 SUBMITTALS

Submit the following to Engineer for approval. Submittals with an “NJDEP” or “EPA” designation require submittal to the New Jersey Department of Environmental Protection or U.S. Environmental Protection Agency, respectively, and as indicated. Submit the following:

SD-02 Shop Drawings

Geomembrane Panel Layout

Penetrations

Geomembrane panel layout and penetration detail drawings, a minimum of 14 days prior to geomembrane placement.

As-Built Drawings

Final as-built drawings of geomembrane installation.

Geomembrane boot and seal

Passive gas vents and valve and cleanout extensions

SD-03 Product Data

Mechanical Anchoring Materials

Tests, Inspections, and Certifications

Manufacturer’s and fabricator’s QC manuals
A minimum of 14 days prior to geomembrane shipment.

Field Seaming

Installer’s QC manual
A minimum of 14 days prior to geomembrane placement.

Qualifications

Manufacturer's and fabricator's qualification statements including resumes of key personnel involved in the project, a minimum of 14 days prior to geomembrane shipment.

Installer's, QC inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in the project a minimum of 14 days prior to geomembrane placement. The submittal from the QC laboratory shall include verification that the laboratory is accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

SD-04 Samples

Samples

Geomembrane QA and QC samples

SD-06 Test Reports

Surface Preparation

Certification from the QC inspector and installer of the acceptability of the surface on which the geomembrane is to be placed, immediately prior to geomembrane placement.

Non-Destructive Field Seam Continuity Testing

QC inspector certified test results on all field seams.

Destructive Field Seam Testing

Installer and certified QC laboratory test results on all destructively tested field seams.

Destructive Seam Test Repairs

QC inspector certified test results on all repaired seams.

Interface Friction Testing

Certified laboratory interface friction test results including description of equipment and test method, a minimum of 14 days prior to geomembrane shipment.

Tests

Certified QC test results

SD-07 Certificates

Samples

Materials

Surface Preparation

Destructive Field Seam Testing

Destructive Seam Test Repairs

Tests

1.4 QUALITY CONTROL

1.4.1 Qualifications

1.4.1.1 Manufacturer

Manufacturer shall have produced the proposed geomembrane sheets for at least 5 completed projects having a total minimum area of 10 million square feet.

1.4.1.2 Fabricator

The fabricator is responsible for seaming geomembrane sheets into panels. Fabricator shall have fabricated the proposed geomembrane panels for at least 5 completed projects having a total minimum area of 2 million square feet.

1.4.1.3 Installer

The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall have installed the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet. At least one seamer shall have experience seaming a minimum of 500,000 square feet of the proposed geomembrane using the same type of seaming equipment and geomembrane thickness specified for this project.

1.4.1.4 QC Inspector

The QC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the QC of the geomembrane from manufacturing through installation. The QC inspector shall have provided QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet.

1.4.1.5 QC Laboratory

The QC laboratory shall have provided QC and/or Quality Assurance (QA) testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Delivery

The QC inspector shall be present during delivery and unloading of the geomembrane. Each geomembrane roll/panel shall be labeled with the

manufacturer's name, product identification number, roll/panel number, and roll dimensions.

1.5.2 Storage

Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate. The geomembrane shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll goods or flattening of the rolls. Rolls shall not be stored more than two high. Damaged geomembrane shall be removed from the site and replaced with geomembrane that meets the specified requirements.

1.5.3 Handling

Rolls/panels shall not be dragged, lifted by one end, or dropped. A pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll. Chains shall be used to link the ends of the pipe or bar to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the roll without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.6 AMBIENT CONDITIONS

Geomembrane shall not be deployed or field-seamed in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. No placement or seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F. Ambient temperature shall be measured at a height no greater than 6 inches above the ground or geomembrane surface. If seaming is allowed below 32 degrees F, the procedures outlined in GSI GRI GM9 shall be followed. In marginal conditions, seaming shall cease unless destructive field seam tests, conducted by the QC laboratory, confirm that seam properties meet the requirements listed in Table 3. Tests shall be conducted in accordance with paragraph Destructive Field Seam Testing.

1.7 EQUIPMENT

Equipment used in performance of the work shall be in accordance with the geomembrane manufacturer’s recommendations and shall be maintained in satisfactory working condition.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Raw Materials

Resin used in manufacturing geomembrane sheets shall be made of virgin uncontaminated ingredients with a density of 0.926 g/ml measured in accordance with ASTM D1505 or ASTM D792 Method B, and a melt index value of less than 1.0 g/10 minutes measured in accordance with ASTM D1238. No more than 10 percent regrind, reworked, or trim material in the form of chips or edge strips shall be used to manufacture the geomembrane sheets. All regrind, reworked, or trim materials shall be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. No post consumer materials or water-soluble ingredients shall be used to produce the geomembrane. For geomembranes with plasticizers, only primary plasticizers that are resistant to migration shall be used. Submit a copy of the test reports and QC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

2.1.2 Sheet Materials

Geomembrane sheets shall be unreinforced and manufactured as wide as possible to minimize factory and field seams. Geomembrane sheets shall be uniform in color, thickness, and surface texture. Geomembrane shall be smooth or textured as indicated. The textured surface features shall consist of raw materials identical to that of the parent sheet material and shall be uniform over the entire face of the geomembrane. The sheets shall be free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants and other imperfections. Geomembrane sheets and factory seams shall conform to the requirements listed in Tables 1 and 2 for Manufacturing Quality Control (MQC).

TABLE 1
SMOOTH LLDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Thickness (min ave)	40.0 mils	per roll	ASTM D5199
Lowest individual of 10 values	36.0 mils	per roll	ASTM D5199
Density (max)	0.939 g/ml	per 200,000 lb	ASTM D1505/ASTM D792
Tensile Properties(1)(min ave)		per 20,000 lb	ASTM D6693 Type IV
- break stress	152 lb/in		
- break elongation	800 percent		
2% Modulus (max)	2400 lb/in	per formulation	ASTM D5323
Tear Resistance (min ave)	22 lb	per 45,000 lb	ASTM D1004

TABLE 1
SMOOTH LLDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Puncture Resistance (min ave)	56 lb	per 45,000 lb	ASTM D4833
Axi-Symmetric Break Resistance Strain (min)	30 percent	per formulation	ASTM D5617
Carbon Black Content	2.0-3.0 percent	per 45,000 lb	ASTM D4218 (2)
Carbon Black Dispersion	Note (3)	per 45,000 lb	ASTM D5596
Oxidative Induction Time (OIT)(4)		per 200,000 lb	
- Standard OIT (min ave)	100 min		ASTM D3895
- High Pressure OIT (min ave)	400 min		ASTM D5885
Oven Aging at 185 degrees F (5)		per year and change in formulation	ASTM D5721
- Standard OIT (min ave) or	35 percent retained after 90 days		ASTM D3895
- High Pressure OIT (min ave)	60 percent retained after 90 days		ASTM D5885
UV Resistance (min ave) (6)		per year and change in formulation	ASTM D7238
High Pressure OIT(7)	35 percent retained after 1600 hours		ASTM D5885

TABLE 2
TEXTURED LLDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Nominal Thickness	40 mils		
Thickness (min ave)	38.0 mils	per roll	ASTM D5994

TABLE 2
TEXTURED LLDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Lowest individual for 8 out of 10 values	36.0 mils	per roll	ASTM D5994
Lowest individual of 10 values	34.0 mils	per roll	ASTM D5994
Asperity Height (min ave) (8)(10)	16 mils	every second roll	ASTM D7466 (9)
Density (max)	0.939 g/ml	per 200,000 lb	ASTM D1505/ASTM D792
Tensile Properties (1)(min ave)		per 20,000 lb	ASTM D6693 Type IV
- break strength	60 lb/in		
- break elongation	250 percent		
2% Modulus (max)	2400 lb/in	per formulation	ASTM D5323
Tear Resistance (min ave)	22 lb	per 45,000 lb	ASTM D1004
Puncture Resistance (min ave)	44 lb	per 45,000 lb	ASTM D4833
Axi-Symmetric Break Resistance Strain (min)	30 percent	per formulation	ASTM D5617
Carbon Black Content	2.0-3.0 percent	per 45,000 lb	ASTM D4218 (2)
Carbon Black Dispersion	Note (3)	per 45,000 lb	ASTM D5596
Oxidative Induction Time (OIT)(4)		per 200,000 lb	
- Standard OIT)(min ave) or	100 min		ASTM D3895
- High Pressure OIT)(min ave)	400 min		ASTM D5885
Oven Aging at 185 degrees F (5)		per year and change in formulation	ASTM D5721
Standard OIT (min ave) or	35 percent retained after 90 days		ASTM D3895
- High Pressure OIT (min ave)	60 percent retained after 90 days		ASTM D5885

TABLE 2 TEXTURED LLDPE GEOMEMBRANE PROPERTIES			
PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
UV Resistance (6)		per year and change in formulation	ASTM D7238
- High Pressure OIT (min ave) (7)	35 percent retained after 1600 hours	per formulation	ASTM D5885

TABLE 1 AND TABLE 2 NOTES	
MQC	Manufacturing Quality Control
Note (1)	Machine direction and cross machine direction average values shall be based on 5 test specimens in each direction. For LLDPE geomembrane, break elongation is calculated using a gage length of 2.0 inches at 2 inches/min.
Note (2)	Other methods such as ASTM D1603 (tube furnace) or ASTM D6370 (thermogravimetric analysis) are acceptable if an appropriate correlation to ASTM D4218 (muffle furnace) can be established.
Note (3)	Carbon black dispersion (near spherical agglomerates only) for 10 different views: - minimum 9 of 10 in Categories 1 or 2 - all 10 in Categories 1, 2, or 3
Note (4)	The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.
Note (5)	Evaluate samples at 30 and 60 days and compare with the 90 day response.
Note (6)	The condition of the test shall be a 20 hour UV cycle at 167 degrees F followed by a 4 hour condensation cycle at 140 degrees F.
Note (7)	UV resistance is based on percent retained value regardless of the original HP-OIT value.
Note (8)	Of 10 readings; 8 out of 10 must be greater than or equal to 7 mils, and lowest individual reading must be greater than or equal to 5 mils.
Note (9)	Alternate the measurement side for double sided textured sheet.
Note (10)	Test properties at minimum frequencies indicated or in accordance with the approved MQC manual, whichever is more stringent.
Note (11)	Table 1 and 2 values meet GSI GRI GM17.

TABLE 3 LLDPE SEAM PROPERTIES		
PROPERTY	TEST VALUE	TEST METHOD
Hot Wedge Fusion Seams		
Seam Shear Strength (min) (1)(4)	60 lb/in	ASTM D6392
Seam Shear Elongation (min) (2)	50 percent	ASTM D6392 and GSI GRI GM19
Seam Peel Strength (min) (1)(4)(5)	50 lb/in	ASTM D6392
Seam Peel Separation (max) (3)	25 percent	ASTM D6392 and GSI GRI GM19
Extrusion Fillet Welded Seams		
Seam Shear Strength (min) (1)(4)	60 lb/in	ASTM D6392
Seam Shear Elongation (min) (2)	50 percent	ASTM D6392 and GSI GRI GM19
Seam Peel Strength (min) (1)(4)	44 lb/in	ASTM D6392
Seam Peel Separation (max) (3)	25 percent	ASTM D6392 and GSI GRI GM19
TABLE 3 NOTES		
Note (1): Seam shear and seam peel strength of 4 out of 5 1.0 inch wide strip specimens greater than or equal to the test value. Seam shear and seam peel strength of fifth specimen greater than or equal to 80 percent of the test value.		
Note (2): Seam shear elongation of 5 out of 5 specimens greater than or equal to the test value. Elongation measurements may be omitted for field testing.		
Note (3): Seam peel separation (or incursion) of 5 out of 5 specimens less than or equal to the test value.		
Note (4): Per their description in ASTM D6392, Separation-in-plane (SIP) is an acceptable break code; AD and AD-Brk greater than 25 percent are unacceptable break codes for fusion welded seams; AD1 and AD2 are unacceptable break codes for extrusion fillet welded seams; and AD-WLD is an unacceptable break code unless the strength test value is met. Five out of 5 specimens shall result in acceptable break patterns.		
Note (5): Both tracks of double wedge fusion seam shall be tested.		

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Interface Friction Testing

Interface friction tests shall be conducted in accordance with ASTM D5321. Normal stresses of 1.0, 1.5, and 3.0 psi along with a displacement rate of 0.04 inches per minute shall be used. Interfaces shall be saturated for a minimum of 24 hours prior to testing. Soil components shall be the same as used for full scale construction and shall be compacted to the same moisture-density requirements specified for full scale field placement. Geosynthetics shall be the same materials as those proposed for use during

full scale construction. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field. A minimum residual interface friction angle of 9.0 degrees is required for all interfaces. Textured geomembrane material subjected to interface friction testing shall be tested for asperity height in accordance with ASTM D7466. A portion of that geomembrane material test sample shall be provided to Engineer for approval. Manufacturer's test results using the same geosynthetic materials, similar soil, and same test conditions may be used in lieu of site-specific interface friction testing subject to Engineer approval.

2.2.2 Manufacturing, Sampling, and Testing

2.2.2.1 Raw Materials

Raw materials shall be tested in accordance with the approved MQC manual. Any raw material which fails to meet the geomembrane manufacturer's specified physical properties shall not be used in manufacturing the sheet. Seaming rods and pellets shall be manufactured of materials which are essentially identical to that used in the geomembrane sheet. Seaming rods and pellets shall be tested for density, melt index and carbon black content in accordance with the approved MQC manual. Seaming rods and pellets which fail to meet the corresponding property values required for the sheet material shall not be used for seaming.

2.2.2.2 Material

Geomembrane sheets shall be tested in accordance with the approved MQC manual. As a minimum, MQC testing shall be conducted at the frequencies shown in Tables 1 and 2. Rolls not meeting the minimum requirements specified in Table 1 shall not be sent to the site.

2.3 MECHANICAL ANCHORING MATERIALS

As indicated. Provide information if alternative materials are proposed.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Surface Preparation

Surface preparation shall be performed in accordance with Section 31 23 00 EXCAVATION AND FILL. Rocks larger than 1/4 inch in diameter and any other material which could damage the geomembrane shall be removed from the surface to be covered with the geomembrane. Construction equipment tire or track deformations beneath the geomembrane shall not be greater than 1.0 inch in depth. Each day during placement of geomembrane, the QC Inspector and installer shall inspect the surface on which geomembrane is to be placed and certify in writing that the surface is acceptable.

3.1.2 Anchor Trenches

Unless otherwise indicated, anchor trenches shall be placed 24 inches back from the edge of the slope to be covered, shall be 12 inches deep and 12 inches wide, and the geomembrane shall extend down the front wall and across

the bottom of the anchor trench. If the anchor trench is excavated in cohesive soil susceptible to desiccation, only the amount of anchor trench required for placement of geomembrane in a single day shall be excavated. Ponded water shall be removed from the anchor trench while the trench is open. Trench corners shall be slightly rounded to avoid sharp bends in the geomembrane. Loose soil, rocks larger than 1/4 inch in diameter, and any other material which could damage the geomembrane shall be removed from the surfaces of the trench. Backfilling and compaction of the anchor trench shall be in accordance with Section 31 23 00 EXCAVATION AND FILL.

3.2 CONTRACTOR'S RESTRICTIONS

No equipment or tools shall be used that damage the geosynthetic materials by handling, trafficking or other means. No personnel working on the geosynthetic materials shall smoke, wear damaging footwear or engage in other activities that can damage the geosynthetic materials. The method used to deploy the geosynthetic materials shall not disturb pipes, backfill, underlying geosynthetics, or surface to receive geomembrane.

The storage of fuel oils and other petroleum products shall be restricted to off cap areas and shall not be located adjacent to or immediately upgradient of geosynthetic covered areas. Equipment maintenance (fueling, replacing oil and filters, etc.) shall not take place on cap areas. Any leakage of petroleum products shall be immediately removed from the geosynthetic covered areas.

The QC Inspector shall visually observe each panel, after placement and prior to seaming for damage. The QC Inspector shall determine which panels or portions of panels shall be rejected, repaired or accepted. Damaged panels or portions of panels which have been rejected shall be marked and their removal or repair recorded by the QC Inspector.

3.3 GEOMEMBRANE DEPLOYMENT

The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. Geomembrane damaged during installation shall be replaced or repaired, at the QC inspector's discretion. Only geomembrane panels that can be anchored and seamed together the same day shall be deployed. Adequate ballast (i.e., sand bags) shall be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. No equipment shall be operated on the top surface of the geomembrane without permission from the Engineer and QC Inspector. Seams shall be oriented parallel to the line of maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel. The methods used to deploy and backfill over the geomembrane shall minimize wrinkles and tensile stresses in the geomembrane. The geomembrane shall have adequate slack to prevent the creation of tensile stress. The wrinkle height to width ratio for installed geomembrane shall not exceed 0.5. In addition, geomembrane wrinkles shall not exceed 6 inches in height. Wrinkles that do not meet the above criteria shall be cut out and repaired in accordance with the installer's approved QC manual.

3.4 FIELD SEAMING

3.4.1 Trial Seams

Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Trial seam samples shall be collected and tested in accordance with ASTM D6392. One sample shall be obtained from each trial seam. This sample shall be at least 36 inches long by 12 inches wide with the seam centered lengthwise. Ten random specimens 1 inch wide shall be cut from the sample. Five seam specimens shall be field tested for shear strength and 5 seam specimens shall be field tested for peel adhesion using an approved quantitative tensiometer. Where necessary, accelerated curing of trial seams made by chemical methods shall be conducted in accordance with GSI GRI GM7. To be acceptable, 4 out of 5 replicate test specimens shall meet seam strength requirements specified in Table 3. If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional trial seam fails, the seaming apparatus or seamer shall not be used until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved.

3.4.2 Field Seams

Panels shall be seamed in accordance with the geomembrane manufacturer's recommendations. In sumps, corners and odd-shaped geometric locations, the number of field seams shall be minimized. Seaming shall extend to the outside edge of panels. Soft subgrades shall be compacted and approved prior to seaming. The seam area shall be free of moisture, dust, dirt, and foreign material at the time of seaming. Fish mouths in seams shall be repaired. The following information shall be recorded for each seam:

1. Panel number
2. Seam number
3. Date and time seam was constructed
4. Temperature of geomembrane at time of seaming
5. Seaming unit designation
6. Name of seamer
7. Seaming equipment temperature and pressures

3.4.2.1 Polyethylene Seams

Polyethylene geomembranes shall be seamed by thermal fusion methods. Extrusion welding shall only be used for patching and seaming in locations where thermal fusion methods are not feasible. Seam overlaps that are to be attached using extrusion welds shall be ground prior to welding. Grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement. Extrusion welding shall begin within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, they shall be ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks shall be no greater than 10 percent of the sheet thickness.

3.5 SAMPLES

A minimum of one QC sample per material type per lot per project or per every 100,000 square feet of material delivered to the site whichever results in the greater number of samples. One QC sample, 18 inches in length, for the entire width of a roll, shall be obtained for every 100,000 square feet of material delivered to the site. Samples shall not be obtained from the first three feet of the roll. For accordion folded geomembranes, samples of equivalent size shall be collected from approved locations. The samples shall be identified by manufacturer's name, product identification, lot and roll/panel number. The date, a unique sample number, and the machine direction shall also be noted. In addition, a 12 inch by 12 inch QA sample shall be collected, labeled, and submitted to the Engineer each time QC samples are collected.

3.6 TESTS

Provide all QC samples to the QC laboratory to determine density, thickness, tensile strength at break, and elongation at break in accordance with the methods specified in Tables 1 and 2. Samples not meeting the specified requirements shall result in the rejection of applicable rolls/panels. As a minimum, rolls/panels produced immediately prior to and immediately after the failed roll/panel shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls/panels on both sides of the original failing roll/panel pass the failed parameter.

3.6.1 Non-Destructive Field Seam Continuity Testing

Field seams shall be non-destructively tested for continuity over their full length in accordance with the installer's approved QC manual. At a minimum, field seams created using a dual hot wedge fusion welder shall be tested by air channel pressure testing in accordance with ASTM D5820. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Any seams which fail shall be documented and repaired in accordance with the installer's approved QC manual.

3.6.2 Destructive Field Seam Testing

A minimum of one destructive test sample per 500 feet of field seam shall be obtained at locations specified by the QC inspector and Engineer. Sample locations shall not be identified prior to seaming. Samples shall be a minimum of 12 inches wide by 42 inches long with the seam centered lengthwise. Each sample shall be cut into 3 equal pieces, with one piece retained by the installer, one piece given to the QC laboratory, and the remaining piece given to the Engineer for QA testing and/or permanent record. Each sample shall be numbered and cross referenced to a field log which identifies: (1) panel number; (2) seam number; (3) date and time cut; (4) ambient temperature within 6 inches above the geomembrane; (5) seaming unit designation; (6) name of seamer; and (7) seaming apparatus temperature and pressures (where applicable). Ten 1 inch wide replicate specimens shall be cut from the installer's sample. Five specimens shall be tested for shear strength and 5 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be in accordance with the approved QC manual. To be acceptable, 4 out of 5 replicate test specimens shall meet the seam strength requirements specified in Table 3. If the field tests pass, 5 specimens shall be tested at the QC laboratory for shear strength and 5 for peel adhesion in accordance with the QC laboratory's approved

procedures. To be acceptable, 4 out of 5 replicate test specimens shall meet the seam strength requirements specified in Table 3. If the field or laboratory tests fail, the seam shall be repaired in accordance with paragraph Destructive Seam Test Repairs. Holes for destructive seam samples shall be repaired the same day they are cut.

3.7 DEFECTS AND REPAIRS

3.7.1 Destructive Seam Test Repairs

Seams that fail destructive seam testing may be overlaid with a strip of new material and seamed (cap stripped). Alternatively, the seaming path shall be retraced to an intermediate location a minimum of 10 feet on each side of the failed seam location. At each location a 12 by 18 inch minimum size seam sample shall be taken for 2 additional shear strength and 2 additional peel adhesion tests using an approved quantitative field tensiometer. If these tests pass, then the remaining seam sample portion shall be sent to the QC laboratory for 5 shear strength and 5 peel adhesion tests in accordance with the QC laboratory's approved procedures. To be acceptable, 4 out of 5 replicate test specimens must meet specified seam strength requirements. If these laboratory tests pass, then the seam shall be cap stripped or repaired using other approved methods between that location and the original failed location. If field or laboratory tests fail, the process shall be repeated. After repairs are completed, the repaired seam shall be non-destructively tested in accordance with paragraph Non-Destructive Field Seam Continuity Testing.

3.7.2 Patches

Tears, holes, blisters and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming as determined by the QC inspector. Repairs shall be non-destructively tested. The Engineer or the QC inspector may also elect to perform destructive seam tests on suspect areas.

3.8 VISUAL INSPECTION AND EVALUATION

Immediately prior to covering, the geomembrane, seams, and non-seam areas shall be visually inspected by the QC inspector and Engineer for defects, holes, or damage due to weather conditions or construction activities. At the Engineer’s or the QC inspector's discretion, the surface of the geomembrane shall be brushed, blown, or washed by the installer if the amount of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Each suspect location shall be non-destructively tested in accordance with paragraph Non-Destructive Field Seam Continuity Testing. Each location that fails non-destructive testing shall be repaired in accordance with paragraph Patches and non-destructively retested.

3.9 PENETRATIONS

Geomembrane penetration details shall be in accordance with ASTM D6497, as recommended by the geomembrane manufacturer, or as otherwise indicated subject to Engineer approval. Factory fabricated boots shall be used wherever possible. Field seams for penetrations shall be non-destructively tested in accordance with the installer’s approved QC manual. Seams that

fail non-destructive testing shall be repaired in accordance with the installer's approved QC manual and non-destructively tested prior to acceptance.

3.10 PROTECTION AND BACKFILLING

The deployed and seamed geomembrane shall be covered with the specified material within 514 calendar days of acceptance. Wrinkles in the geomembrane shall be prevented from folding over during placement of cover materials. Cover soil shall not be dropped onto the geomembrane or overlying geosynthetics from a height greater than 3 feet. The soil shall be pushed out over the geomembrane or overlying geosynthetics in an upward tumbling motion. Cover materials shall be placed from the bottom of the slope upward. The initial loose cover material thickness shall result in a minimum initial lift thickness of 6 inches. Equipment ground pressure limits and cover thickness shall be as follows:

COVER THICKNESS (minimum)	EQUIPMENT GROUND PRESSURE (maximum)
6 inches	5.0 psi
12 inches	6.0 psi
18 inches	7.5 psi
24 inches	8.0 psi

The initial list of cover material placed above the geomembrane shall be compacted in a systematic manner to ensure 100 percent coverage is provided. Compact areas not accessible to large scale construction equipment and materials including aggregates with mechanical hand tampers in a systematic manner to ensure 100 percent coverage is provided. Density testing requirements may be waived by the Engineer provided the lift or area provides a stable and firm surface. Cover soil compaction and testing requirements are described in Section 32 23 00 EXCAVATION AND FILL. Equipment placing cover materials shall not stop abruptly make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

3.11 AS-BUILT DRAWINGS

Submit final as-built drawings of the geomembrane installation. These drawings shall include panel numbers, seam numbers, location of repairs, destructive seam samples, and penetrations.

-- End of Section --

SECTION 02 56 15

GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1505	(2010) Density of Plastics by the Density-Gradient Technique
ASTM D5199	(2012) Measuring Nominal Thickness of Geosynthetics
ASTM D5261	(2010) Measuring Mass Per Unit Area of Geotextiles
ASTM D5887	(2016) Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5888	(2006; R 2016) Standard Guide for Storage and Handling of Geosynthetic Clay Liners
ASTM D5889	(2016) Standard Practice for Quality Control of Geosynthetic Clay Liners
ASTM D5890	(2011) Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D5891	(2002; R 2016; E 2016) Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D5993	(2014) Measuring Mass Per Unit of Geosynthetic Clay Liners
ASTM D5994	(2010; R 2015; E2015) Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6072	(2009; R 2015) Obtaining Samples of Geosynthetic Clay Liners
ASTM D6243	(2016) Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method

ASTM D6496	(2004a; R 2015; E 2015) Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D6768	(2004; R 2015; E 2015; E 2015) Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement

1.2 SUBMITTALS

Submit the following to Engineer for approval. Submittals with an “NJDEP” or “EPA” designation require submittal to the New Jersey Department of Environmental Protection or U.S. Environmental Protection Agency, respectively, and as indicated. Submit the following:

SD-02 Shop Drawings

Layout and Detail Drawings
GCL penetration detail drawings

SD-03 Product Data

Manufacturer's Quality Control (QC) Manual
GCL Properties

Manufacturer’s certified raw and roll material data sheets. If needle punching or stitch bonding is used in construction of GCL, the certification shall indicate that the GCL has been continuously inspected for broken needles using an in-line metal detector and all broken needles have been removed. The certified data sheets shall be attested to by a person having legal authority to bind the GCL manufacturing company. Certified test results shall be submitted as least 14 working days prior to delivery of the GCL.

Warranty
Tests, Inspections, and Verifications

Manufacturer’s quality control (QC) manual which describes testing procedures, frequency of testing and acceptance/rejection criteria for QC testing at least 14 days prior to delivery of the GCL.

Qualifications

Manufacturer's qualification statements including resumes of key personnel involved in this project.

SD-04 Samples

Samples

Deliver QC samples at the specified frequencies.

SD-06 Test Reports

Tests, Inspections, and Verifications

SD-07 Certificates

Geosynthetic clay liner

A minimum of 14 days prior to scheduled use, manufacturer's certificate of compliance stating that the geosynthetic clay liner meets the requirements of this section. The certificate of compliance shall be attested to by a person having legal authority to bind the geosynthetic clay liner manufacturer.

1.3 QUALIFICATIONS

1.3.1 Manufacturer

Geosynthetic clay liner shall be the product of a GCL Manufacturer who has produced the proposed GCL using the same bentonite, geotextiles, sewing thread, and adhesive for at least 5 completed projects and shall have produced a minimum of 2,000,000 square feet of the proposed GCL. The laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the laboratory will be required to perform.

1.4 DELIVERY, STORAGE, AND HANDLING

Delivery, storage, and handling of GCL shall be in accordance with ASTM D5888.

1.4.1 Delivery

Delivery, storage, and handling of GCL shall be in accordance with ASTM D 5888. The Engineer shall be present during unloading of the GCL. Rolls shall be packaged in an opaque, waterproof, protective covering and wrapped around a central core. Tears in the packaging shall be repaired to restore a waterproof protective barrier around the GCL. Unloading of rolls from the delivery vehicles shall be done in a manner that prevents damage to the GCL and its packaging.

1.4.2 Storage

Field storage shall be in flat dry areas, above the ground surface where water cannot accumulate and the GCL rolls can be protected from damage. Storage of the rolls on blocks or pallets will not be allowed unless the GCL rolls are fully supported as approved by the Engineer. Stacks of GCL rolls shall be no greater than three high. Rolls shall be covered with a water proof tarpaulin or plastic sheet if stored outdoors.

1.4.3 Handling

During handling, rolls shall not be dragged, lifted by one end, dropped to the ground, or otherwise damaged. A pipe or solid bar of sufficient strength to support the full weight of the roll without significant bending shall be used for all unloading and handling activities. If recommended by

the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.5 DETAIL DRAWINGS

Submit detail drawings, for approval, a minimum of 14 days prior to installation.

PART 2 PRODUCTS

2.1 GCL PROPERTIES

GCL shall be a manufactured product consisting of a sodium montmorillonite clay (bentonite) layer evenly distributed between two geotextiles. GCL shall conform to the property requirements listed in Table 1 and shall be free of tears, holes, or other defects that may affect its serviceability. Encapsulating geotextiles shall be mechanically bonded together using a needle punch or stitch bonding process. Needle punched and stitch bonded GCLs shall be continuously inspected for broken needles using an in-line metal detector and broken needles shall be removed. GCL panels shall be continuously marked with non-toxic waterproof ink 12 inches from both edges. Ink color shall be different from that of the geotextile. The minimum manufactured GCL panel width shall be 13.5 feet and the minimum manufactured GCL panel length shall be 98 feet.

TABLE 1
GCL PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	CQC TESTING FREQUENCY (MIN)
BENTONITE			
Swell Index Test, minimum	ASTM D5890	24 mL	
Fluid Loss, maximum	ASTM D5891	18 mL	
UPPER GEOTEXTILE PROPERTIES			
Material Type		Woven or Nonwoven	
Mass per Unit Area, min. - Woven or - Nonwoven (2)	 ASTM D5261 ASTM D5261	 3.0 ounces/sq yd 5.9 ounces/sq yd	
LOWER GEOTEXTILE PROPERTIES			
Material Type		Nonwoven	
Mass per Unit Area, min.	ASTM D5261	5.9 ounces/sq yd	
COMPOSITE			
Bentonite Mass/Unit Area, minimum, Note 3	ASTM D5993	0.75 lbs/sq foot	
GCL Mass/Unit Area, minimum, Note 3	ASTM D5993	0.81 lbs/sq foot	per 5000 sq yd
Moisture Content, maximum	ASTM D5993	35 percent	
Tensile Strength, minimum, (MD)	ASTM D6768	23 lbs/in	per 25000 sq yd

TABLE 1
GCL PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	CQC TESTING FREQUENCY (MIN)
Index Flux, maximum	ASTM D5887	1.0×10^{-6} cubic cm/sec-sq cm	per 30000 sq yd
Peel Strength, MARV MD	ASTM D6496	2.1 lbs/inch	per 5000 sq yd

Note 1: Upper (cap) and lower (carrier) designations refer to the respective orientation during manufacturing and not necessarily to the as-placed orientation.
Note 2: Upper or lower geotextile shall contain a scrim component with mass per unit area greater than 2.9 ounces/square yard for dimensional stability.
Note 3: Bentonite mass/unit area shall be computed at 0 percent moisture content. Bentonite mass/unit area is exclusive of glues added to the bentonite.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Manufacturing Sampling and Testing

GCL and its components shall be sampled and tested in accordance with the manufacturer's approved QC manual. The manufacturer's QC procedures shall be in accordance with ASTM D5889. Test results not meeting the requirements specified in Table 1 shall result in the rejection of applicable rolls. The manufacturer's QC manual shall describe procedures used to determine rejection of applicable rolls. As a minimum, rolls produced immediately prior to and immediately after the failed roll shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls on both sides of the original failing roll pass the failed parameter.

PART 3 EXECUTION

3.1 SAMPLES AND TESTS

3.1.1 Samples

Collect QC samples at approved locations upon delivery to the site at indicated frequencies. Samples shall be collected, packaged, and transported in accordance with ASTM D6072. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot and roll number. The date, a unique sample number, the machine direction, and the top surface of the GCL shall also be noted on the sample. The outer layer of the GCL roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the GCL sheet a minimum of 3 feet wide in the machine direction. An additional 24 by 24 inch QA sample shall be collected, labeled, and submitted to the Engineer each time QC samples are collected.

3.1.2 Conformance Tests

Provide QC samples to the QC laboratory to determine bentonite mass per unit area (ASTM D5993), peel strength (ASTM D6496), flux (ASTM D5887) and tensile strength (ASTM D6768). Tests not meeting the requirements specified in

Table 1 shall result in the rejection of applicable rolls. Determination of applicable rolls shall be as described in paragraph Tests, Inspections and Verifications.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

The subgrade shall be compacted in accordance with Section 31 23 00 EXCAVATION AND FILL. The subgrade surface shall be smooth and free of vegetation, standing water, and angular stones or other foreign matter that could damage the GCL. At a minimum, the subgrade surface shall be rolled with a smooth-drum compactor of sufficient weight to remove any wheel ruts, footprints, or other abrupt grade changes. All protrusions extending more than 0.5 inches from the subgrade surface (or less if recommended by the manufacturer) shall either be removed, crushed, or pushed into the surface with the smooth-drum compactor. Each day during placement, the Engineer (or their authorized representative) and installer shall inspect the surface on which GCL is to be placed and the installer shall certify in writing that the surface is acceptable.

3.2.2 Placement

GCL shall be installed as soon as practical after completion and approval of the subgrade. Rolls shall be delivered to the work area in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. GCL which has been hydrated prior to being covered by an overlying geomembrane or a minimum of 12 inches of cover soil shall be removed and replaced. Hydrated GCL is defined as having become soft as determined by squeezing the material with finger pressure or material which has exhibited swelling. If the subgrade is soil, construction equipment may be used to deploy GCL. If the subgrade is a geosynthetic material, GCL shall be deployed by hand or by use of approved light weight equipment with pneumatic tires which will not damage the underlying geosynthetic material. GCL shall not be dragged over the ground surface. Deployed GCL panels shall lie flat on the subgrade surface, with no wrinkles or folds and be in direct contact with the subgrade.

3.2.3 Seams

On side slopes, GCL shall be placed with seams oriented parallel to the line of maximum slope and shall be free of tension or stress upon completion of installation. Panels shall be positioned with the overlap recommended by the manufacturer, but not less than 6 inches for panel sides or 18 inches for panel ends. Soil or other foreign matter shall be removed from the overlap area immediately prior to seaming. Granular bentonite of the same type as the bentonite used for the GCL shall be placed continuously along the entire overlap width at a minimum rate of 0.25 lbs/linear foot or as recommended by the manufacturer whichever application rate is greater. Granular bentonite shall not be placed nor permitted to enter the underlying geocomposite drainage layer. Construction adhesive or other approved seaming methods recommended by the manufacturer shall be used for horizontal seams on slopes. Overlaps which occur on slopes shall be constructed with the up slope GCL shingled over the down slope GCL. Alternate seaming methods may be approved if recommended by the manufacturer.

3.2.4 GCL Field QA

When deployed, GCL shall be visually inspected for needles and scanned with a hand-held device to verify manufacturer's quality control for needle removal. Scanning frequency may be reduced if approved by the Engineer. Discontinuous stitches, unraveled stitches, rust spots, and suspect areas shall be inspected for needles. Needles shall be removed and the damaged area repaired.

3.2.5 Protection

Only those GCL panels which can be anchored and covered in the same day shall be unpackaged and installed. If exposed GCL cannot be permanently covered before the end of a working day, it shall be temporarily covered with plastic or other waterproof material to prevent hydration.

3.3 REPAIRS

Holes or tears in GCL shall be repaired by placing a patch of GCL extending a minimum of 12 inches beyond the edges of the hole or tear on all sides. Granular bentonite or bentonite mastic shall be applied at a minimum rate of 0.25 lbs/linear foot in the overlap area. Patches shall be secured with a construction adhesive or other approved methods as recommended by the manufacturer.

3.4 PENETRATIONS

Provide watertight seal for penetrations through GCL. Penetration details shall be as indicated and as recommended by the GCL manufacturer whichever is more stringent subject to Engineer approval. Provide GCL with seams aligned over appurtenance or carefully cut the GCL to be penetrated using a sharp utility knife. For GCL locations not underlain by natural or geocomposite gas venting or drainage layers, 1) provide 3 inch minimum depth notch sloped at 1 horizontal to 1 vertical or flatter completely around appurtenance, and 2) fill notch with granular bentonite to elevation of GCL to form a watertight seal. Provide GCL collar using new GCL extending 24 inches minimum beyond limit of removed, cut and/or damaged GCL. GCL collar shall be in direct contact with penetration; the collar may be cut to improve its fit around the penetration (e.g. "starburst" or "pie" pattern). Provide granular bentonite of the same type as the bentonite used for the GCL continuously along the entire overlap width at a minimum application rate of 0.25 lbs/linear foot or as recommended by the manufacturer whichever application rate is greater. Secure GCL collar to prevent movement or dislodging during subsequent material placement.

3.5 COVERING

GCL shall not be covered prior to inspection and approval by the Engineer. Cover soil shall be free of angular stones or other foreign matter which could damage the GCL. The maximum particle size of cover soil overlying and in contact with GCL shall be 1 inch. Cover soil shall not be dropped directly onto the GCL from a height greater than 3 feet. The soil shall be pushed out over the GCL in an upward tumbling motion. The direction of backfilling shall proceed in the direction of downgradient shingling of GCL overlaps; except that on side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall be placed such that soil does not enter the GCL overlap zone and tensile stress are not mobilized in the

GCL. No equipment shall be operated on the top surface of the GCL without permission from the Engineer. The initial loose soil lift thickness shall be 12 inches. Equipment with ground pressures less than 7.0 psi shall be used to place the first lift over the GCL. A minimum of 12 inches of soil shall be maintained between construction equipment with ground pressures greater than 7 psi and the GCL during the covering process. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph. Cover soil compaction and testing requirements are described in Section 31 23 00 EXCAVATION AND FILL.

-- End of Section --

SECTION 31 05 19

GEOTEXTILE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4354	(2012) Sampling of Geosynthetics for Testing
ASTM D4491	(2015) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2016) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4759	(2011) Determining the Specification Conformance of Geosynthetics
ASTM D4873	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D7238	(2017) Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GT13(a)	(2017; Rev4) Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate

1.2 SUBMITTALS

Submit the following to Engineer for approval. Submittals with an “NJDEP” or “EPA” designation require submittal to the New Jersey Department of

Environmental Protection or U.S. Environmental Protection Agency, respectively, and as indicated. Submit the following:

SD-03 Product Data

Thread

A minimum of 14 days prior to scheduled use, proposed thread type for sewn seams along with data sheets showing the physical properties of the thread.

Manufacturing Quality Control Sampling and Testing

A minimum of 14 days prior to scheduled use, manufacturer’s quality control manual.

SD-04 Samples

Quality Assurance Samples and Tests

Samples for quality assurance testing; assign 14 days in the schedule to allow for testing.

SD-06 Test Reports

Sewn seam strength

SD-07 Certificates

Geotextile

A minimum of 14 days prior to scheduled use, manufacturer’s quality control test results and manufacturer’s certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needs which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

1.3 DELIVERY, STORAGE, AND HANDLING

Label, deliver, store, and handle geotextile in accordance with ASTM D4873.

1.3.1 Delivery

Notify the Engineer a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Label each roll with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.3.2 Storage

Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate.

1.3.3 Handling

Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

1.4 LABORATORY QUALIFICATIONS

Laboratories shall have performed quality control and/or quality assurance testing of the geotextiles for at least five completed projects having a total minimum area of 2 million square feet. The laboratories shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the laboratory will be required to perform.

PART 2 PRODUCTS

2.1 RAW MATERIALS

2.1.1 Geotextile

Provide geotextile that is a nonwoven (as indicated in Tables 1 and 2) needle punched pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Add stabilizers and/or inhibitors to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Finish the edges of the geotextile to prevent the outer fiber from pulling away from the geotextile. Geotextiles shall meet the requirements specified in Tables 1 and 2. Where applicable, Tables 1 and 2 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll value and corresponding 95 percent opening size (O_{95}) represents the maximum average roll values (MaxARV).

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR
6 OZ/SY SEPARATION GEOTEXTILE (4)

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
Grab Tensile Strength	lbs	158	ASTM D4632

TABLE 1 MINIMUM PHYSICAL REQUIREMENTS FOR 6 OZ/SY SEPARATION GEOTEXTILE (4)			
Elongation Break	percent	≥ 50	ASTM D4632
Sewn Seam Strength	lbs	142	ASTM D4632
CBR Puncture Strength	lbs	320	ASTM D6241
Trapezoidal Tear Strength	lbs	56	ASTM D4533
Apparent Opening Size	U.S. sieve	No. 30 (1)	ASTM D4751
Permittivity	sec -1	0.02	ASTM D4491
Ultraviolet Stability	percent	70 at 500 hrs	ASTM D7238

(1) O_{95} not greater than 0.024 inch.
(2) Evaluation to be on 50mm strip tensile specimens after 500 hours exposure.
(3) Minimum MQC testing frequency of 1 test per 40,000 square feet unless otherwise indicated. Minimum MQC testing frequency of one test per material for sewn seam strength, apparent opening size, and permittivity. Ultraviolet stability based on manufacturer's historical data.
(4) Table 1 values meet GSI GRI GT13(a) Table 1(b) – Geotextile Properties Class 2 (Moderate Survivability).

TABLE 2 MINIMUM PHYSICAL REQUIREMENTS FOR 8 OZ/SY SEPARATION GEOTEXTILE (4)			
PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
Grab Tensile Strength	lbs	203	ASTM D4632
Elongation Break	percent	≥ 50	ASTM D4632
Sewn Seam Strength	lbs	183	ASTM D4632
CBR Puncture Strength	lbs	440	ASTM D6241

TABLE 2 MINIMUM PHYSICAL REQUIREMENTS FOR 8 OZ/SY SEPARATION GEOTEXTILE (4)			
Trapezoid Tear Strength	lbs	79	ASTM D4533
Apparent Opening Size	U.S. sieve	No. 30 (1)	ASTM D4751
Permittivity	sec -1	0.02	ASTM D4491
Ultraviolet Stability	percent	80 at 500 hrs	ASTM D7238

(1) O_{95} not greater than 0.024 inch.
(2) Evaluation to be on 50mm strip tensile specimens after 500 hours exposure.
(3) Minimum MQC testing frequency of 1 test per 40,000 square feet unless otherwise indicated. Minimum MQC testing frequency of one test per material for sewn seam strength, apparent opening size, and permittivity. Ultraviolet stability based on manufacturer's historical data.
(4) Table 2 values meet GSI GRI GT13(a) Table 1(a) – Geotextile Properties Class 1 (High Survivability)

2.1.2 Thread

Construct sewn seams with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Provide documentation describing the quality control program. Perform manufacturing quality control sampling and testing in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D4759. Submit MQC test results. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 QUALITY ASSURANCE SAMPLES AND TESTS

3.1.1 Quality Assurance Samples

Provide assistance to the Engineer in the collection of quality assurance samples for quality assurance testing. Collect samples upon delivery to the site in accordance with ASTM D4354, Procedure B. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile. Identify samples with a

waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

3.1.2 Quality Assurance Tests

Provide quality assurance samples to a laboratory independent from the laboratory utilized for manufacturer’s quality control testing. Geotextile and geotextile seam samples shall be tested to verify that geotextile and geotextile seams meet the requirements specified in Tables 1 and 2. Test method ASTM D7238 shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable roll.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 02 56 13 WASTE CONTAINMENT GEOMEMBRANE and Section 31 23 00 EXCAVATION AND FILL.

3.2.2 Placement

Notify the Engineer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. At the time of installation, reject the geotextile if it has defects, rips, holes, deterioration or damage incurred during manufacture, transportation or storage. Geotextile shall be laid flat, smooth, free of tensile stresses, folds, wrinkles, and in direct contact with the subgrade. On slopes steeper than 10 horizontal on 1 vertical, lay the geotextile with the machine direction of the fabric parallel to the slope direction.

3.3 SEAMS

3.3.1 Overlap Seams

Continuously overlap geotextile panels a minimum of 12 inches at all longitudinal and transverse seams unless specified otherwise. Where seams must be oriented across the slope, lap the upper panel over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

3.3.2 Sewn Seams

Sew seams of geotextile with thread of a material meeting the chemical requirements indicated. Seams shall be continuously sewn on all slopes steeper than 1 vertical on 4 horizontal. Sew using “butterfly” seam and 401 two thread locking chain stitch or as recommended by the manufacturer. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. Sewn seam strength

shall meet the minimum requirements specified in Tables 1 and 2. The minimum distance from the geotextile edge to the stitch line nearest to that edge shall be 3 inches unless otherwise recommended by the manufacturer. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of 18 inches of overlap.

3.4 PROTECTION

Protect the geotextile during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Use adequate ballast (e.g. sand bags) to prevent uplift by wind. In no case shall any type of equipment be allowed on the unprotected geotextile. The geotextile shall not be left uncovered for more than 14 days after installation.

3.5 REPAIRS

Repair torn or damaged geotextile. Clogged areas of geotextile shall be removed. Perform repairs by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Remove and replace geotextile rolls which cannot be repaired.

3.6 PENETRATIONS

Construct engineered penetrations of the geotextile as indicated or by methods recommended by the geotextile manufacturer.

3.7 COVERING

Do not cover geotextile prior to inspection and approval by the Engineer and the QC Inspector. Place cover material in a manner that prevents material from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, backfill shall be placed from the bottom of the slope upward. Soil cover material shall not be dropped onto the geotextile from a height greater than 3 feet. Coarse aggregate cover material shall not be dropped onto the geotextile from a height greater than 1 foot. No equipment shall be operated directly on top of the geotextile without approval of the Engineer. Use equipment with ground pressures less than 7 psi to place the first lift over the geotextile. A minimum of 12 inches of material shall be maintained between full-scale construction equipment and the geotextile. Equipment placing cover material shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --

SECTION 31 05 20

GEOSYNTHETIC DRAINAGE LAYER

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1505	(2010) Density of Plastics by the Density-Gradient Technique
ASTM D1603	(2014) Carbon Black Content in Olefin Plastics
ASTM D4218	(2015) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4355	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491	(2015) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4716	(2008; R 2013) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4751	(2016) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D5035	(2011) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D5199	(2012) Measuring Nominal Thickness of Geosynthetics
ASTM D5261	(2010) Measuring Mass Per Unit Area of Geotextiles

ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D7005	(2003; R 2008) Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites

1.2 SUBMITTALS

Submit the following to Engineer for approval. Submittals with an “NJDEP” or “EPA” designation require submittal to the New Jersey Department of Environmental Protection or U.S. Environmental Protection Agency, respectively, and as indicated. Submit the following:

SD-03 Product Data

Sampling and Testing

Manufacturer’s quality control manual

Construction Quality Control (QC) Laboratory

Qualifications of laboratory.

SD-04 Samples

Geocomposite Drainage Layer
Seams and Overlaps

One properly identified 24 by 24 inch minimum size geocomposite drainage layer sample for each material indicated; fasteners proposed for use; and the method of seaming and overlapping.

SD-06 Test Reports

Sampling and Testing

Construction quality control test results.
Geocomposite Drainage Layer

Manufacturer’s quality control test results.

SD-07 Certificates

Geocomposite Drainage Layer

A minimum of 14 days to scheduled use, manufacturer’s certificate of compliance stating that the geocomposite drainage layer meets the requirements of this section. The certificate of compliance shall be attested to by a person having legal authority to bind the geocomposite drainage layer manufacturer.

1.3 QUALITY ASSURANCE

Quality control (QC) laboratory shall have provided QC and quality assurance (QA) testing, if required, of geocomposite drainage layers for at least five completed projects, having a total minimum area of 2 million square feet. The laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests it will be required to perform.

1.4 DELIVERY, STORAGE, AND HANDLING

The QC inspector shall be present during delivery and unloading of the geocomposite drainage layer. Ensure the geocomposite drainage layer material has not been damaged during shipping, storage, or handling. Any geocomposite drainage layer material found to be damaged shall be repaired or replaced. Accept delivery of material only after the required submittals have been approved. Each roll shall be labeled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic. Store the rolls in a level and dry area.

Geocomposite drainage material shall be protected from becoming saturated. Rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic. Geocomposite drainage layer rolls or sheets shall be protected from dust, dirt, construction equipment, ultraviolent radiation, chemicals, sparks and flames, temperatures in excess of 160 degrees F, and any other environmental conditions that may damage the physical properties of the geocomposite drainage layer.

Geocomposite drainage layer rolls or sheets shall be handled and unloaded with load carrying straps, a fork lift with stinger bar, or an axle bar assembly. Rolls shall not be dragged along the round, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 GEOCOMPOSITE DRAINAGE LAYER

The polymer used to manufacture the geonet component of the geocomposite drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Submit one properly identified 24 by 24 inch minimum size geocomposite drainage layer sample; fasteners proposed for use; and the method of seaming and overlapping. Submit manufacturer's quality control test results. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used. Geocomposite drainage layer shall meet the property requirements listed in Table 1. The geonet shall be covered on one or both sides as indicated with nonwoven needle-punched geotextile. Create geocomposite by heat bonding geotextile to the geonet. The geotextile shall not be bonded to the drainage net within 6 inches of the edges of the rolls or sheets. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

TABLE 1
GEOCOMPOSITE DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
GEONET COMPONENT			
Thickness, minimum avg, Note 1	ASTM D5199	200 mil	100,000 sq ft
Polymer Density, minimum avg	ASTM D1505	0.940 g/cc	Note 6
Carbon Black Content	ASTM D1603 ASTM D4218	1-3 percent	100,000 sq ft
Tensile Strength, minimum avg, Note 2	ASTM D5035	45 lbs/inch	100,000 sq ft
GEOTEXTILE COMPONENT			
Mass/Unit Area, MARV	ASTM D5261	6.0 oz/sy	100,000 sq ft
Grab Strength, MARV	ASTM D4632	157 lbs	100,000 sq ft
Grab Elongation, MARV	ASTM D4632	50 percent	100,000 sq ft
Trapezoidal Tear Strength, MARV	ASTM D4533	55 lbs	100,000 sq ft
CBR Puncture Strength	ASTM D6241	320 lbs	100,000 sq ft
Permittivity, MARV	ASTM D4491	0.2/sec	500,000 sq ft
AOS(O95), MaxARV	ASTM D4751	0.25 mm	500,000 sq ft
UV Stability, percent retained (500 hours)	ASTM D4355	70 percent	Note 3
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles, Note 4	ASTM D4716	- 4.8 gal/min-foot (single sided) - 0.5 gal/min-foot (double-sided) Note 7	200,000 sq ft
Geonet/Geotextile Adhesion, minimum avg, Note 5	ASTM D7005	0.5 lbs/inch	100,000 sq ft

Note 1: The diameter of the presser foot shall be 2.22 inches and the pressure shall be 2.9 psi. For other thickness options, see manufacturer's literature.

Note 2: Average peak value for five equally spaced machine direction tests across the roll width.

Note 3: Manufacturer's historical data.

Note 4: For single and double sided geocomposite drainage layer, measure manufacturing quality control transmissivity tests using gradient of 0.1 under a minimum normal pressure of 10,000 psf. Use a minimum seating period of 15 minutes. Perform the test between rigid end platens.

Note 5: Average of five tests across the roll width. Discounting the outer 1 foot of each side of the roll, collect samples at the 10, 30, 50, 70, and 90 percent positions across the roll width. Test both sides for double sided geocomposites.

TABLE 1 GEOCOMPOSITE DRAINAGE LAYER PROPERTIES			
PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
Note 6: Once per project.			

2.2 SAMPLING AND TESTING

2.2.1 Manufacturing Quality Control Testing

Manufacturing quality control test methods and frequencies shall be in accordance with Table 1 unless otherwise approved. Submit manufacturer's quality control manual and construction quality control test results.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Surface Preparation

Prior to placement of the geocomposite drainage layer, the subgrade shall be smooth and free of all materials which could damage the geocomposite drainage layer.

3.1.2 Placement

The geocomposite drainage layer shall not be damaged during placement. Unroll the drainage layer in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. The geocomposite drainage layer shall not be dragged across textured geomembrane if a geotextile is attached to the surface facing the geomembrane. During placement of geocomposite, care shall be taken not to entrap dirt or dust in the geotextile or geonet that could cause clogging of the system. Dirt or dust entrapped shall be washed clean with water prior to placement of the next material on top of it. Place adequate ballast (e.g. sandbags) to prevent uplift by wind prior to covering. Care should be taken with the handling of sandbags to prevent rupture or damage of the sandbags.

3.1.3 Seams and Overlaps

3.1.3.1 Geonet Side Seams

Overlap geonet side seams a minimum of 4 inches. Side seam fastener spacing shall be a maximum of 5 feet. In anchor trenches, fastener spacing shall be a maximum of 1 foot.

3.1.3.2 Geonet End Seams

Overlap geonet end seams a minimum of 1 foot. End seam fastener spacing shall be a maximum of 1 foot. The overlaps shall be in the direction of flow. End seams shall not be allowed on side slopes steeper than 4 horizontal on 1 vertical.

3.1.3.3 Geonet Fasteners

Tie geonet rolls together with plastic fasteners. The fasteners shall be a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.

3.1.3.4 Geotextile Seams

The bottom layers of geotextile shall be overlapped. The top layer of geotextile shall be continuously sewn in accordance with Section 31 05 19 GEOTEXTILE. Geotextile shall be overlapped a minimum of 4 inches prior to sewing.

3.1.3.5 Geotextile Cap Strips

Place geotextile cap strips over any exposed edges of geocomposite. Cap strips shall be a minimum of 2 feet in width and shall be thermally bonded to the geotextile component of the geocomposite by methods that do not damage the geotextile.

3.1.4 Stacked Geocomposite Drainage Layers

When geocomposite drainage layers are to be stacked, stagger roll ends and edges so that joints do not lie above one another. Stacked layers shall be laid in the same direction and in a manner that prevents interlocking.

3.1.5 Penetrations

Submit penetration details. Mechanically attach a geotextile apron to pipes and other appurtenances penetrating through the geocomposite drainage layer so that soil is prevented from getting into the geocomposite drainage layer. The apron of the attached geotextile shall extend out from the pipe or appurtenance a minimum of 2 feet. The apron geotextile shall be thermally bonded to the geotextile.

3.2 REPAIRS

3.2.1 Geonet Damage

Make repairs by placing a patch of the geocomposite drainage layer over the damaged area. Extend the patch a minimum of 2 feet beyond the edge of the damage. Use approved fasteners, spaced every 6 inches around the patch, to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.2.2 Geotextile Damage

Repair damaged geotextile by placing a patch of geotextile over the damaged area with a minimum of 12 inches of overlap in all directions. The geotextile patch shall be sewn or thermally bonded in place by methods that do not damage the geotextile.

3.3 PROTECTION AND BACKFILLING

Cover the geocomposite drainage layer with the specified materials within 14 days of acceptance. The QC Inspector shall be present during covering of

the geocomposite drainage layer. Cover materials shall be placed in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.

-- End of Section --

SECTION 31 21 00

PIPING; OFF-GAS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM D1248	(2012) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D2513	(2014; E 2014) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D3035	(2015) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3892	(1993; R 2009) Packaging/Packing of Plastics
ASTM F1055	(2016) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing
ASTM F2620	(2016) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

NEW JERSEY DEPARTMENT OF TRANSPORTATION (NJDOT)

NJDOT SHS	(2007) Updated Standard Specifications for Road and Bridge Construction

1.2 SYSTEM DESCRIPTION

The off-gas piping system shall consist of buried and above ground pipe.

1.3 SUBMITTALS

Submit the following to Engineer for approval. Submittals with an “NJDEP” or “EPA” designation require submittal to the New Jersey Department of Environmental Protection or U.S. Environmental Protection Agency, respectively, and as indicated. Submit the following:

SD-02 Shop Drawings

Off-Gas Piping System

SD-03 Product Data

Materials and Equipment

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Packaging

Plastic pipe shall be packed, packaged and marked in accordance with ASTM D3892.

1.4.2 Storage

Store materials with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Piping bundles shall be stored on a prepared surface and should not be stacked more than two bundles high.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment that are new and unused, except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. Piping material and appurtenances shall be as indicated and shall be suitable for the service intended. Submit manufacturer's descriptive data and technical literature for each type of pipe, including pressure and temperature ratings, dimensions, type, grade and strength of pipe and fittings, thermal characteristics (coefficient of expansion and thermal conductivity) and chemical resistance. Manufacturer's recommended installation procedures including materials preparation and installation.

2.1.1 Identification

Each piece of pipe shall bear the ASTM designation and the ASTM markings required for that designation.

2.2 POLYETHYLENE (PE) PIPING

Design and fabrication of below grade components of the off-gas piping system shall be in accordance with ASTM D2513 except as modified herein.

2.2.1 PE Pipe

Pipe shall be in accordance with ASTM D3035, Schedule 80, size as indicated. Melt flow shall be less than 1.5 g/10 min. with method ASTM D1248, Condition F. Environmental stress crack resistance shall exceed 1000 hours, ASTM D1693, Condition C.

2.2.2 PE Joints and Fittings

Fittings shall be pressure rated electrofusion fittings in accordance with ASTM F1055 or butt heat fusion fittings in accordance with ASTM D3261.

2.2.3 Pipe Perforations

Water inlet area shall be a minimum of 0.5 square inches per lineal foot. Manufacturer’s standard perforated pipe which essentially meets these requirements may be substituted with prior approval of Engineer.

2.2.3.1 Circular Perforations

Circular holes shall be cleanly cut not more than 1/2 inch or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows.

2.2.3.2 Slotted Perforations

Circumferential slots shall be cleanly cut so as not to restrict the inflow of fluid and uniformly spaced along the length and circumference of the pipe. Width of slots shall not exceed 1/2 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch dimeter pipe, or 10 percent of the pipe inside nominal circumference on 4 to 8 inch diameter pipe. Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe.

2.3 FILTER MATERIAL

NJDOT SHS, Section 901.03 Coarse Aggregate, Table 901.03-1, Coarse Aggregate No. 67 for gradation and NJDOT SHS, Section 901.03.01 Broken Stone for quality.

2.4 SEALANTS

Sealants shall conform to ASTM C920 Type S, Grade NS, Class 50, Use NT, G, A and O.

PART 3 EXECUTION

3.1 INSTALLING PIPE UNDERGROUND

Installation shall be as specified in Section 31 00 00 EARTHWORK, except as modified herein; and as required by ASTM D2774 for polyethylene pipe.

3.2 INSTALLING PIPE ABOVEGROUND

Install vertical pipe plumb in all directions. Piping shall be secured in position by approved methods when piping is to stand free, or when no structural element is available for providing stability during construction. Temporary caps or plugs shall be provided at pipe openings at the end of each day’s work.

3.3 JOINING PIPE

Butt fusion in accordance with ASTM F2620.

-- End of Section --

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C136	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	(2016) Standard Specification for Portland Cement
ASTM C33	(2016) Standard Specification for Concrete Aggregates
ASTM C39	(2016) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1556	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017) Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)
ASTM D2937	(2017) Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
ASTM D422	(1963; R 2007; E 2014; E 2014; withdrawn 2016) Standard Test Method for Particle-Size Analysis of Soils

ASTM D4253	(2016) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2008) Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating
ASTM D4944	(2011) Standard Test Method for Field Determination of Water (Moisture) Content of Soil by Calcium Carbide Gas Pressure Test
ASTM D4959	(2016) Standard Test Method for Determination of Water Content of Soil By Direct Heating
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D6023	(2015) Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM)
ASTM D6103	(2004; WK42984 reinstatement) Flow Consistency of Controlled Low-Strength Material (CLSM)
ASTM D6938	(2017) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION (NJDEP)

NJDEP FMG	(2015 Version 3.0) Fill Material Guidance for SRP Sites, Site Remediation Program

NEW JERSEY DEPARTMENT OF TRANSPORTATION (NJDOT)

NJDOT SHS	(2007) Updated Standard Specifications for Road and Bridge Construction

1.2 DEFINITIONS

1.2.1 Degree of Compaction

Degree of compaction is expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698, for general soil types, abbreviated as “percent laboratory maximum density”, unless otherwise indicated. Since ASTM D698 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with ASTM D698 and corrected with ASTM D4718.

1.2.2 Coverage

Coverage, C, as used herein:

$C = (A_f / A_d) \times N \times 100$ percent

where

N = number of passes of the approved compaction equipment over a given point;

A_f = sum of the end contact areas of the feet on the drums of the compaction equipment; and,

A_d = average surface area of the drum itself based on the average of the diameter over feet and diameter over drum.

Note that the coverage provided by a one-directional pass of a steel wheeled roller with full width front and rear drums is 200 percent. The coverage provided by a one-directional pass of a tracked piece of equipment is 100 percent.

1.3 QUALIFICATIONS

Geotechnical material testing by a commercial testing laboratory or Contractor’s validated testing facility for all appropriate fields of testing. Submit qualifications of the commercial testing laboratory or Contractor’s validated testing facilities. If Contractor elects to establish testing facilities, do not permit work requiring testing until Contractor’s facilities have been inspected, validated and approved by the Engineer.

Environmental laboratory approved by one of the four third-party Accrediting Bodies and shall also hold current National Environmental Laboratory Accreditation Conference (NELAC) accreditation for all appropriate fields of testing. Submit qualifications of the environmental laboratory including quality systems manual.

1.4 SUBMITTALS

Submit the following to Engineer for approval. Submittals with an “NJDEP” or “EPA” designation require submittal to the New Jersey Department of Environmental Protection or U.S. Environmental Protection Agency, respectively, and as indicated. Submit the following:

SD-01 Preconstruction Submittals

Work Plan
Submit a minimum of 15 calender days prior to starting work.

Schedule of Activities

Requirements for off-site soil

Compaction equipment

SD-03 Product Data

Commercial Testing Laboratory
Environmental Laboratory

SD-06 Test Reports

Borrow Site Testing

Fill and backfill test

Select material test

Density tests

Moisture Content Tests

CLSM test results

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

SD-07 Certificates

CLSM certificate
CLSM producer certification

1.5 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of materials.

1.6 WORK PLAN

Submit a Work Plan within 30 calendar days after notice to proceed. No work at the site, with the exception of site inspections and surveys, shall be performed until the Work Plan is approved. Allow 14 calendar days in the schedule for Engineer's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, the Work Plan shall include the following items:

a. Schedule of activities.

b. Equipment to be used, including make, model, and data sheets.

c. Key personnel names, qualifications, and training certifications.

d. Method of excavation, grading, and compaction.

e. Method of run-off control.

f. Dewatering plan for impounded water, water resulting from excavations, and water from excavated material.

g. Method(s) of conditioning or otherwise stabilizing unsuitable materials to a suitable condition. Preference shall be given to moisture conditioning via mechanically turning the material with reliance on environmental factors (i.e. sunlight, wind, and temperature) to reduce the moisture content of the material to suitable levels. Provide contingency methodologies including, but not limited to, addition of stabilization agents such as Portland cement or kiln dust.

h. Borrow sources, haul routes, and stockpile location(s).

i. Geosynthetic materials installation and protection methods.

j. Decontamination procedures.

k. Spill contingency plan.

l. Site restoration plan.

1.6.1 Schedule of Activities

Submit Schedule of Activities for the entire project that is a forward planning as well as a project monitoring tool. Contractor management personnel must actively participate in its development. Indicate the proposed sequence to perform the work and dates contemplated for starting and completing all schedule activities. Provide in Gantt format using the Critical Path Method (CPM) of network calculation and precedence diagrams. Develop the Project Schedule to the appropriate level of detail to address major milestones and to allow for satisfactory project planning and execution. Provide updated Schedule of Activities on a biweekly frequency.

1.7 REQUIREMENTS FOR OFF SITE SOIL

Off site soil in accordance with NJDEP FMG requirements.

Contractor shall provide Engineer open access to the off site soil and aggregate source(s) for the purposes of inspection and obtaining samples for quality assurance testing.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Satisfactory Materials

ASTM D2487 group symbol GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, CL, ML, CL-ML, CH, and MH free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. Unless

otherwise indicated, the maximum particle diameter shall be one-half the lift thickness at the intended location.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 3 inches.

2.1.3 Common Fill

ASTM D2487, group symbol GW, GP, GM, GC, SW, SP, SM, and SC, maximum 50 percent by weight passing ASTM D1140, No. 200 sieve, and maximum particle size of 1 inch.

2.1.4 Landfarm Material

Material resulting from excavation and regrading of soil material located within No. 1 Landfarm limits.

2.1.5 Select Landfarm Material

Material resulting from excavation and regrading of soil material located within No. 1 Landfarm limits with maximum particle size of 1 inch.

2.1.6 AOC-3 Related Material

Soil and non-soil material located outside of No. 1 Landfarm limits related to operation of, or migration from, AOC-3 No. 1 Landfarm. Non-soil material shall have a maximum particle size of 2 inches. Material may be excavated and consolidated within No. 1 Landfarm limits beneath the cap system subject to Engineer approval.

2.2 COARSE AGGREGATE

Natural, durable, competent material meeting NJDOT SHS, Section 901.03 Coarse Aggregate, Table 901.03-1, Coarse Aggregate for gradation and NJDOT SHS, Section 901.03.01 Broken Stone for quality. Gradation as indicated.

2.3 CLAY MATERIAL

Free of roots, debris, organic or frozen material, and shall have a maximum clod size of 2 inches at time of compaction.

TABLE 1
PHYSICAL PROPERTIES OF CLAY

PROPERTY	UNITS	ACCEPTABLE VALUE	TEST METHOD
Particle size, max	inches	1	ASTM D422
Percent passing No. 4 sieve, min	percent	80	ASTM D422
Percent passing No. 200 sieve, min	percent	50	ASTM D1140
Liquid limit, min	percent	35	ASTM D4318
Plasticity index, min	percent	10	ASTM D4318
Plasticity index, max	percent	40	ASTM D4318

2.4 CONTROLLED LOW-STRENGTH MATERIAL

NJDOT SHS, Section 903.09 Controlled Low Strength Material (CLSM) with ASTM C39 28 day compressive strength of 50 to 150 pounds per square inch and maximum ASTM D5084 hydraulic conductivity of 1.7×10^{-3} centimeters per second. Submit CLSM certificate from producer attesting to conformance with NJDOT requirements.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Drainage and Dewatering

Provide for the containment, collection, conveyance, treatment, sampling and testing as required, and discharge of surface and subsurface water encountered within the No. 1 Landfarm limits during construction.

3.1.1.1 Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep materials sufficiently dry. Establish/construct storm drainage features at the earliest stages of construction, and throughout construction grade the surrounding construction area to provide positive surface water runoff away from the construction activity. Contain water within the No. 1 Landfarm limits using temporary ditches, dikes, swales, and other drainage features and equipment as required. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material. Moisture condition or otherwise stabilize removed unsuitable material and place within No. 1 Landfarm limits beneath the cap system. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.1.1.2 Dewatering

Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, safely facilitate sampling, and ensure that compaction requirements can be met.

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Control measures shall be implemented by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least one foot below the working level unless otherwise approved by Engineer.

Dewatering liquid shall be managed appropriately via approved methods that may include:

a) collection, filtration to remove suspended sediment, on-site treatment at existing leachate treatment system, and discharge to surface water under existing General Permit Authorization (GPA);

b) collection, filtration, characterization, on-site pretreatment if necessary, and discharge to publicly owned treatment works (POTW);

c) collection, filtration, characterization, on-site treatment, and discharge; and

d) collection, filtration, characterization, on-site pretreatment if necessary, and transport and treatment/disposal at an off-site POTW or off-site treatment, storage, and disposal facility (TSDF).

Existing leachate treatment system is operated in accordance with individual NJPDES/DSW General Permit Authorization under the General Groundwater Petroleum Product Cleanup (B4B) Permit which allows for the discharge of treated leachate through the discharge outfall of approximately 1000 gallons per day (average) and 2500 gallons per day (maximum).

3.1.2 Underground Utilities

Physically verify the location and elevation of existing utilities prior to starting construction. Scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered. Excavation made with power-driven equipment is not permitted within two feet of known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand or using the air/vacuum extraction technique. Start hand excavation or air/vacuum extraction on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the excavation until approval for backfill is granted by Engineer.

3.1.3 Machinery and Equipment

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Report damage to utility lines or subsurface construction immediately to the Engineer. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.2 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Remove unsatisfactory material encountered below the indicated grades as directed by Engineer and replace with suitable material. If located outside of No. 1 Landfarm limits, refill with Common Fill and compact to minimum 90 percent laboratory maximum density. If located within No. 1 Landfarm limits refill with 1) removed material after removed material is moisture conditioned or otherwise stabilized, 2) Common Fill compacted to minimum 90 percent laboratory maximum density, or 3) Landfarm Material compacted to provide a firm, stable, and nonyielding surface.

Satisfactory material removed below the depths indicated, without specific direction of the Engineer, shall be replaced with satisfactory materials to the indicated excavation grade.

3.3 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials in accordance with paragraph Excavation and as directed by the Engineer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density or to a firm, stable, and nonyielding surface as directed by the Engineer. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by padfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved compaction equipment well suited to the material being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.3.1 Proof Rolling

Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, clearing, and grubbing or excavation, proof roll the exposed subgrade with 400 percent coverage of a minimum 40,000 pound tracked piece of equipment with a minimum ground pressure of 7.0 psi, six one-directional passes of a dump truck loaded with 12 cubic feet of soil, or minimum 400 percent coverage with a 15 ton, pneumatic-tired roller. Operate the equipment in a systematic manner to ensure the number of passes over all areas, and at speeds between 2 1/2 to 3 1/2 miles per hour. When proof rolling, one-half of the coverage made with the roller shall be in a direction perpendicular to the other coverages. Notify the Engineer a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the Engineer. Undercut rutting or pumping as directed by the Engineer to a depth of 12 inches and replace with Common Fill if located outside of No. 1 Landfarm limits or Landfarm material if located within No. 1 Landfarm limits. Repairs shall be compacted until accepted by Engineer.

If located outside of No. 1 Landfarm limits, undercut rutting and pumping area as directed by Engineer and refill with Common Fill compacted to minimum 90 percent laboratory maximum density unless otherwise indicated. If located within No. 1 Landfarm limits undercut rutting and pumping area as directed by Engineer and refill with 1) Common Fill compacted to minimum 90 percent laboratory maximum density or 2) Landfarm Material compacted to provide a firm, stable, and nonyielding surface.

3.4 GRADING AREAS

Divide work into grading areas within which regraded material will be placed in embankments, fills, and required backfills. Maintain stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber tired equipment or provision of a temporary plastic cover, the ground surface at stockpile locations; separately stockpile regraded No. 1 Landfarm materials from imported materials. Protect stockpiles of imported materials from contamination that may destroy the quality and fitness of the imported material.

3.5 FILLING AND BACKFILLING

Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

Number and account for, at the end of each shift, grade stakes if utilized to monitor lift thickness of layers underlying geosynthetic materials (i.e., Common Fill or Select Landfarm Material layer underlying geosynthetic cap barrier layers). Grade stakes shall not be utilized to monitor thickness of layers overlaying geosynthetic materials (i.e., Common Fill overlaying geosynthetic cap barrier layers). When removing grade stakes, no broken portion of the grade stake shall be left in the Common Fill or Select Landfarm Material layer.

3.5.1 Landfarm, Select Landfarm and AOC-3 Related Material Placement

Place in 8 inch loose lifts. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Finish to a smooth surface by blading, rolling with a smooth roller, or both.

3.5.2 Common Fill Placement

Place in 8 inch loose lifts. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Finish to a smooth surface by blading, rolling with a smooth roller, or both.

3.5.3 Coarse Aggregate Placement

Place in 6 inch loose lifts. Backfill adjacent to structures shall be placed as structural elements are completed and accepted.

3.5.4 Clay Material Placement

Place in 8 inch loose lifts unless otherwise indicated. Place in 6 inch loose lifts when hand operated equipment is used. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compaction shall be accomplished by padfoot rollers,

pneumatic-tired rollers or other approved compaction equipment well suited to the material being compacted.

3.6 COMPACTION

3.6.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to minimum 90 percent laboratory maximum density.

3.6.2 Structures, Spread Footings, and Concrete Slabs

Compact top 12 inches of subgrades within 5 feet line of and beneath paved area or structure to minimum 95 percent laboratory maximum density. Compact Common Fill to minimum 95 percent laboratory maximum density.

3.6.3 Adjacent Area

Compact areas within 5 feet of and beneath structures to minimum 95 percent laboratory maximum density.

3.6.4 Paved Areas

Compact top 12 inches of subgrades to minimum 95 percent laboratory maximum density. Compact fill and backfill materials to minimum 95 percent laboratory density or minimum 70 percent of ASTM D4253 and ASTM D4254 relative density.

3.6.5 Landfarm, Select Landfarm, and AOC-3 Related Materials Compaction

Compact with minimum of 400 percent coverage using Engineer approved compaction equipment to provide a firm, stable, and unyielding surface, subject to Engineer approval.

3.6.6 Common Fill Compaction

Minimum 90 percent laboratory maximum density unless otherwise indicated.

3.6.7 Clay Material Compaction

Minimum 90 percent laboratory maximum density unless otherwise indicated.

3.7 FINISH OPERATIONS

3.7.1 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.7.2 Protection of Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.8 FIELD QUALITY CONTROL

3.8.1 Sampling

Take the number and size of samples required to perform the following tests.

3.8.2 Testing

Perform one of each of the following tests for each material used. Provide additional tests for each source change.

3.8.2.1 Common Fill and Clay Material Testing

Test material in accordance with ASTM C136, ASTM D422, and ASTM D4318 for conformance to ASTM D2487; ASTM D4318 for liquid limit and for plastic limit; ASTM D698 for moisture density relations or ASTM D4253 and ASTM D4254, as applicable. One test per 10,000 cubic yards stockpiled or in-place source material, for changes in material consistency, or minimum of one test per source, whichever is greater.

3.8.2.2 Common Fill and Clay Material Density Tests

Test density in accordance with ASTM D1556 , ASTM D2937 or ASTM D6938. When ASTM D6938 density tests are used, verify density test results by performing an ASTM D1556 or ASTM D2937 density test at a location already ASTM D6938 tested as specified herein. Perform an ASTM D1556 or ASTM D2937 density test at the start of the job, and for every 20 ASTM D6938 density tests thereafter. Test each lift at randomly selected locations every 10,000 square feet.

Test density of first lift of Common Fill placed above geosynthetic materials in accordance with ASTM D1556 or ASTM D2937 at randomly selected locations every 10,000 square feet. ASTM D6938 density testing of first lift of Common Fill placed above geosynthetic material shall not be performed so as not to puncture the underlying geosynthetic materials.

3.8.2.3 Common Fill and Clay Material Moisture Content Tests

ASTM D6938, ASTM D4643, ASTM D4944, ASTM D4959, or ASTM D2216. When other than ASTM D2216 moisture tests are used, verify moisture test results by performing an ASTM D2216 moisture test at a location already tested by other methods and at a frequency of one ASTM D6938 test for every 20 non-ASTM D6938 moisture tests.

3.8.2.4 Landfarm, Select Landfarm and AOC-3 Related Material Testing

ASTM D2488 visual-manual classification.

3.8.2.5 Landfarm, Select Landfarm and AOC-3 Related Density Testing

Landfarm, Select Landfarm and AOC-3 related materials shall be compacted to provide a firm, stable, and nonyielding surface as determined by the Engineer. Materials that are not firm and stable, yield, or otherwise demonstrate instability shall be excavated and mixed with satisfactory material to create a stable mixture subject to Engineer approval.

Test Landfarm, Select Landfarm and AOC-3 related material density *for informational purposes only* if directed by Engineer with Engineer's determination based on material shearing strength and compressibility during compaction, workability, and particle size distribution. Test in accordance with ASTM D1556, or ASTM D2937 or ASTM D6938. When ASTM D6938 density tests are used, verify density test results by performing an ASTM D1556 or ASTM D2937 density test at a location already ASTM D6938 tested as specified herein. Perform an ASTM D1556 or ASTM D2937 density test at the start of the job, and for every 20 ASTM D6938 density tests thereafter. Test each lift at randomly selected locations every 10,000 square feet. Include density test results in daily field activity report.

3.8.2.6 Landfarm, Select Landfarm and AOC-3 Related Moisture Testing

Test Landfarm, Select Landfarm and AOC-3 related material moisture *for informational purposes only* if directed by Engineer with Engineer's determination based on material shearing strength and compressibility during compaction, workability, and particle size distribution. Test in accordance with ASTM D6938, ASTM D4643, ASTM D4944, ASTM D4959, or ASTM D2216. When other than ASTM D2216 moisture tests are used, verify moisture test results by performing an ASTM D2216 moisture test at a location already tested by other methods and at a frequency of one ASTM D6938 test for every 20 non-ASTM D6938 moisture tests.

3.8.2.7 Coarse Aggregate Material Testing

Demonstrate conformance with material specification requirements by one of the following:

a. provide documentation that material was obtained from an NJDOT approved source and provide producer/supplier certification and current (less than 1 month) test results on representative samples that demonstrate conformance to specification requirements; or

b. test material in accordance with ASTM C136 for conformance to specification requirements. One test per 2,500 cubic yards of stockpiled or in- place source material or minimum of one test per source or for changes in material consistency, whichever is greater.

3.8.3 Controlled Low Strength Material Documentation

Provide documentation that material was obtained from an NJDOT approved source and provide CLSM producer certification and current (less than 1 month) CLSM test results on representative samples that demonstrate conformance to specification requirements.

3.9 SURVEYS

Survey shall be performed by a professional surveyor registered in the State of New Jersey. Survey grid coordinates shall reference New Jersey State Plane Coordinate System, North American Datum (NAD) of 1983 and elevations shall reference North American Vertical Datum 1988 (NAVD 88). Survey plans shall be prepared at a scale of 1 inch equals 30 feet with a contour interval of 1 foot.

3.9.1 Topographic and Physical Features Survey

a. Physical features: Provide survey of existing No. 1 Landfarm features evidenced during regrading, modification, or retrofit activities, physical features extended including cleanouts, vents, and valves associated with liquid management system, and passive gas vents. Provide location, ground surface, and top and bottom of feature elevations as appropriate.

b. No. 1 Landfarm subgrade surface: Survey subgrade surface prior to placing geosynthetic components of coarse aggregate surfaced cap.

c. No. 1 Landfarm final grade surface: Survey final surface of coarse aggregate surfaced cap.

3.9.2 Check Surveys

Provide survey checks of cap system, including but not limited to, the surface to receive geosynthetic materials (i.e., Geocomposite Gas Venting Layer, GCL, 40 mil LLDPE Geomembrane, and Geocomposite Drainage Layer), protective layer (i.e., top of Common Fill/bottom of NJDOT Coarse Aggregate), and top of NJDOT Coarse Aggregate to demonstrate that the materials are acceptably placed in the work. Provide survey checks of each layer as the work progresses to verify indicated lines, grades and thicknesses. Check survey locations shall be fixed and established using a construction baseline with offsets (i.e., fixed grid). Cross sections shall be taken on lines 50 feet apart, measured along the construction baseline, with readings at 50-feet intervals, at grade breaks along the cross section lines, at critical locations, and as directed by Engineer. Other cross section spacing and reading intervals may be used if determined appropriate by Engineer. Following placement of each layer or type of material, check survey of each layer shall be approved by Engineer before proceeding with the next step of the work.

3.9.3 Layer Thickness Check

Provide layer thickness check of coarse aggregate surfaced cap system, including but not limited to, thickness of protective layer (i.e., Common Fill) and thickness of NJDOT Coarse Aggregate layer to demonstrate that the materials are placed to the indicated thicknesses. Provide layer thickness check of layers at same time as Check Survey as the work progresses. Layer thickness check shall utilize the location control established under paragraph “Check Surveys”. Provide layer thickness check during initial placement of each layer or type of material, at locations of maximum proposed grade where consolidation settlement is anticipated to be at a maximum, and as directed by Engineer. Excavation for layer thickness check shall be by hand or using the air/vacuum extraction technique and shall be performed in the presence of Engineer. Layer thickness check of each layer shall be approved by Engineer before proceeding with the next step of the work.

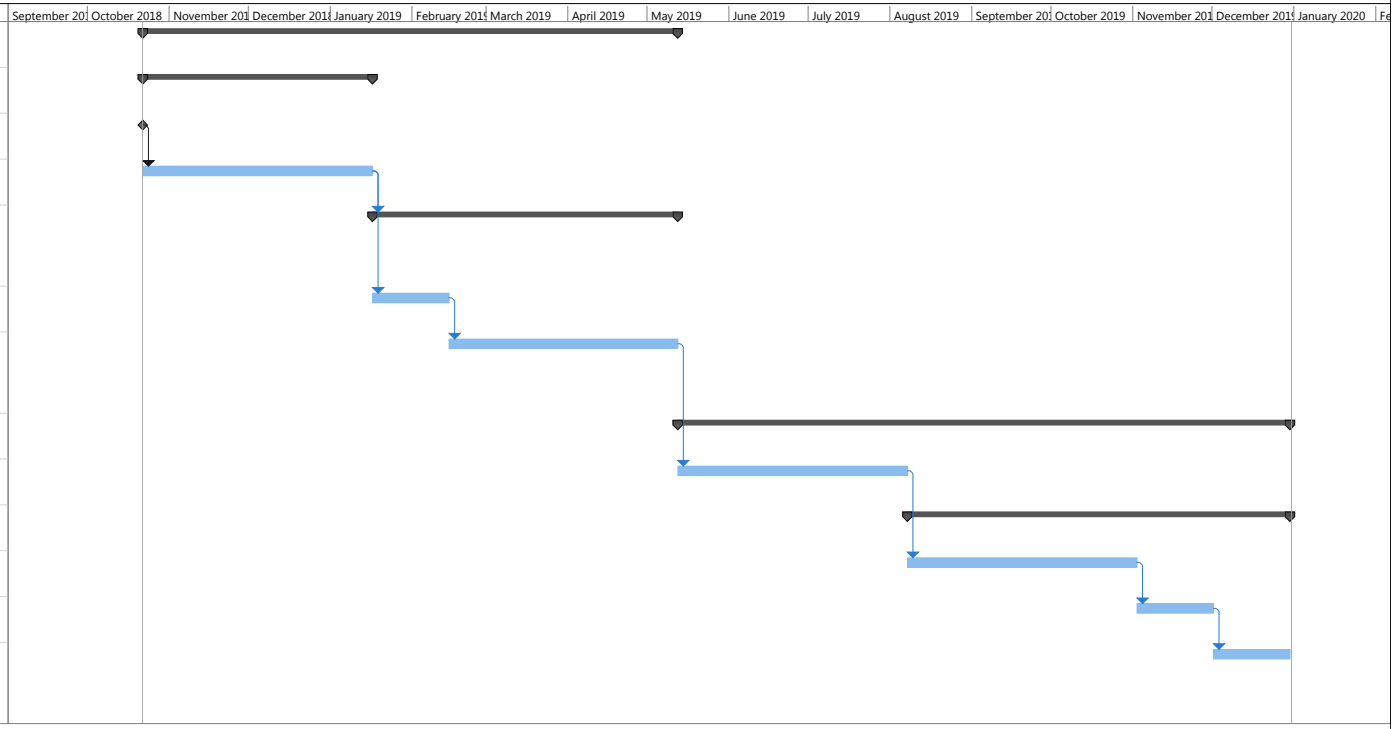
-- End of Section--

APPENDIX E

PROJECT SCHEDULE

Project Schedule
Soil Remedial Action Design
AOC-3: No. 1 Landfarm
Hess Corporation - Former Port Reading Refining Facility
Port Reading, Middlesex County, New Jersey

ID	Task Name	Duration	Start
1	**Soil Remedial Action Design Schedule**	**210 days**	**10/22/18**
2	**90% Soil Remedial Action Design**	**90 days**	**10/22/18**
3	90% Soil RAD Submission	0 days	10/22/18
4	Review and Approval of 90% Soil RAD	90 days	10/22/18
5	**Final (100%) Soil Remedial Action Design**	**120 days**	**1/17/19**
6	Prepare Final (100%) Soil RAD	30 days	1/17/19
7	Review and Approval of 100% Soil RAD	90 days	2/15/19
8	**Remedial Action Schedule**	**240 days**	**5/12/19**
9	Subcontractor Procurement	90 days	5/12/19
10	**Remedial Construction**	**150 days**	**8/7/19**
11	Remedial Action Construction	90 days	8/7/19
12	Prepare Remedial Action Report	30 days	11/2/19
13	LSRP Review and Submit RA Report to NJDEP	30 days	12/1/19



Project: Alt 1
Date: 10/29/18

Task Split Milestone Summary

APPENDIX F

CONSTRUCTION COST ESTIMATE

COST ESTIMATE
SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION
FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

Item No.	Item Description	Units	Quantity	Unit Cost	Total Cost
Direct Capital Costs					
1.0	***Mobilization and Site Preparation***				
1.1	Mobilization/Demobilization	LS	1	$ 144,126	$ 144,126
1.2	Erosion and Sediment Controls	LS	1	$ 6,263	$ 6,263
1.3	Temporary Decontamination Pad	LS	1	$ 1,900	$ 1,900
1.4	Demolition of Drainage Features (RCP, Lysimeters)	LS	1	$ 4,000	$ 4,000
1.5	Extension of Valve and Cleanouts	LS	1	$ 1,000	$ 1,000
1.6	Survey Control and As-Builts	LS	1	$ 20,000	$ 20,000
1.7	Decommission/Retrofit Treatment System	LS	1	$ -	$ -
1.8	Standing Water Removal and Treatment	LS	1	$ -	$ -
2.0	***No. 1 Landfarm Cap System***				
2.1	Clearing and Grubbing	ACRE	3	$ 800	$ 2,400
2.2	Temporary Runoff Control	LS	1	$ 10,000	$ 10,000
2.3	Proof Roll Subgrade	BCY	2,380	$ 0.92	$ 2,190
2.4	Excavation of Subgrade Material	BCY	524	$ 4.06	$ 2,127
2.5	Import of Common Fill Material (Subgrade)	LCY	11,325	$ 38.00	$ 430,350
2.6	Backfill of Subgrade Material	LCY	655	$ 1.50	$ 983
2.7	Compaction of Subgrade/Common Fill Material	BCY	15,926	$ 0.83	$ 13,218
2.8	6" Thick Coarse Aggregate Layer	LCY	2,407	$ 34.65	$ 83,403
2.9	Non-woven Geotextile	SY	13,746	$ 4.28	$ 58,833
2.10	18" Common Fill	LCY	8,582	$ 38.00	$ 326,116
2.11	Geonet Drainage Layer	SY	13,746	$ 7.87	$ 108,181
2.12	Geomembrane	SY	13,746	$ 8.57	$ 117,803
2.13	Geosynthetic Clay Liner	SY	13,746	$ 10.53	$ 144,745
2.14	Geonet Gas Venting Layer	SY	13,746	$ 7.32	$ 100,621
2.15	Cap Termination Stone	LCY	159	$ 36.33	$ 5,776
2.16	Passive Gas Vents	EACH	3	$ 275	$ 825
2.17	Geomembrane Boot	EACH	3	$ 175	$ 525
				Subtotal Direct Capital Costs	$ 1,585,385
3.1			Scope Contingency	5%	$ 79,269
3.2			Bid Contingency	10%	$ 166,465
3.3			General Contingency	15%	$ 249,698
				Total Direct Capital Costs	$ 2,080,818
Indirect Capital Costs					
4.1	Construction Oversight			10%	$ 208,082
				Subtotal Indirect Capital Costs	$ 208,082
				Total	**$ 2,288,900**

See attached sheets for estimate notes and assumptions.

NOTES AND ASSUMPTIONS
SOIL REMEDIAL ACTION DESIGN
AOC-3: NO. 1 LANDFARM
HESS CORPORATION
FORMER PORT READING REFINING FACILITY
PORT READING, MIDDLESEX COUNTY, NEW JERSEY

Direct Capital Costs

1.0 Mobilization and Site Preparation

Item 1.1: Assumed 10% of direct capital costs. Percentage estimated from KEY's past experience.

Item 1.2: Assumed 1,800 linear feet of silt fence required. Cost for silt fence obtained from RSMeans Line Item No. 312514161000, "Synthetic erosion control, silt fence, install and maintain, remove, 3' high" for a cost of $2.18/LF. Added 10% per month for maintenance, assuming 3 months. Assumed stabilized construction access area of 600 sf. Cost of $7/SY obtained from contractor for construction of access road stone. Assumed $2/SY for geotextile obtained from RSMeans Line Item No. 334123190100, "Geotextile subsurface drainage filtration, fabric, laid in trench, polypropylene, ideal conditions." Marked up 10% to account productivity decrease due to Level D safety requirements.

Item 1.3: Assumed decontamination pad area of 1000 sf (40 ft x 25 ft). Multiplied area by $9/sy using same material assumption found in Line Item 3. Assumed additional $0.40/sf for geomembrane material and $500 for timbers.

Item 1.4: Estimated from KEY's past experience.

Item 1.5: Estimated from KEY's past experience.

Item 1.6: Estimated from KEY's past experience assuming surveying crew and office labor to complete as-built drawings.

Item 1.7: To be completed by others.

Item 1.8: To be completed by others.

2.0 No.1 Landfarm Cap System

Item 2.1: RSMeans Line Item No. 311313101040 "Selective tree and shrub removal, selective clearing brush mowing, medium density, tractor with rotary mower, excludes removal offsite." Area calculated from construction drawings. Marked up 10% to account productivity decrease due to Level D safety requirements.

Item 2.2: Estimated from KEY's past experience. Includes physical diversion and collection of stormwater. Storage and treatment costs included in Item 1.8.

Item 2.3: RSMeans Line Item No. 312323235040 "Compaction, riding, vibrating roller, 4 passes, 6" lifts." Area of 2.95 acres calculated from construction drawings. Marked up 10% to account productivity decrease due to Level D safety requirements.

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Item 2.4: RSMeans Line Item No. 312316462020 “Excavating, bulk, dozer, open site, bank measure, common earth, 80 HP dozer, 50’ haul.” Quantity estimated from cut volume obtained from design surfaces. Marked up 10% to account productivity decrease due to Level D safety requirements.

Item 2.5: Cost of $36.50/LCY for fill dirt obtained from Promatcher for Newark, NJ. Assumed 1 BCY = 1.25 LCY and added $1.50/LCY for dozer spreading per RSMeans Line No. 312323142020, "Backfill, structural, common earth, 80 HP dozer, 50' haul, from existing stockpile, excludes compaction." Chemical analytical costs incidental to unit cost.

https://dirt-delivery.promatcher.com/cost/newark-nj-dirt-delivery-costs-prices.aspx

Item 2.6: RSMeans Line Item No. 312323142020 “Backfill, structural, common earth, 80 HP dozer, 50’ haul, from existing stockpile, excludes compaction.” Accounts for backfill of cut material from Landfarm (i.e., not imported). Chemical analytical costs incidental to unit cost.

Item 2.7: RSMeans Line Item No. 312323235040 “Compaction, riding, vibrating roller, 4 passes, 6” lifts.” Quantity used accounts for subgrade compaction and compaction of general fill material found in Line Item 14 and converted from LCY to BCY assuming 1.25 LCY = 1 BCY.

Item 2.8: Assumed 6" coarse aggregate material. Cost of $23.80/ton for aggregate obtained from Stavola Stone, delivered, assuming 7% sales tax. Assumed delivered as LCY and 1 LCY = 1.4 tons. Added $1.33/LCY for dozer spreading per RSMeans Line No. 312323142000, "Backfill, structural, sand and gravel, 80 HP dozer, 50' haul, from existing stockpile, excludes compaction." Subtracted quantity of stone required for cap termination.

Item 2.9: Cost of $0.68/SY for 6 oz/sy geotextile obtained from vendor. Assumed additional $0.40/SF ($3.60/SY) for installation. Area of 2.84 acres calculated from construction drawings.

Item 2.10: Quantity of 8,582 LCY obtained from cut/fill final surface volume to subgrade surface and subtracted quantity of cover stone. Assumed Cost of $36.50/LCY for fill dirt obtained from Promatcher for Newark, NJ. Assumed 1 BCY = 1.25 LCY and added $1.50/LCY for dozer spreading per RSMeans Line No. 312323142020, "Backfill, structural, common earth, 80 HP dozer, 50' haul, from existing stockpile, excludes compaction." Chemical analytical costs incidental to unit cost.

Item 2.11: Cost of $4.27/SY for double sided geonet obtained from vendor. Assumed additional $0.40/SF ($3.60/SY) for installation. Area of 2.84 acres calculated from construction drawings.

Item 2.12: Cost of $2.72/SY for 40 mil textured geomembrane obtained from vendor. Assumed additional $0.65/SF ($5.85/SY) for installation. Area of 2.84 acres calculated from construction drawings.

Item 2.13: Cost of $4.68/SY for GCL, doubled sided geotextile obtained from vendor. Assumed $0.10 increase for freight charges. Assumed additional $0.65/SF ($5.85/SY) for installation. Area of 2.84 acres calculated from construction drawings.

Item 2.14: Cost of $3.72/SY for single sided geonet obtained from vendor. Assumed additional $0.40/SF ($3.60/SY) for installation. Area of 2.84 acres calculated from construction drawings.

Item 2.15: Volume of termination stone required calculated from detail assuming wedge of 4ft x 1.33 ft around entire perimeter of cap. Assumed 6" coarse aggregate material. Cost of $25/ton for aggregate obtained by assuming 5% increase in cost in comparison to #2 aggregate to account for larger stone. Added 7% for sales tax. Assumed delivered as LCY and 1 LCY = 1.4 tons. Added $1.33/LCY for dozer spreading per RSMeans Line No. 312323142020, "Backfill, structural, sand and gravel, 80 HP dozer, 50' haul, from existing stockpile, excludes compaction."

Item 2.16: Estimated $100 for material costs from typical HDPE piping and assumed $150 for labor for perforations and assembly. Marked up 10% to account productivity decrease due to Level D safety requirements.

Item 2.17: Cost obtained from https://www.btlliners.com/product/pipe-sleeve-kit-boot/ assuming geomembrane boot for 6” diameter pipe. Assumed $100 per geomembrane boot for installation.

3.0 Contingency

Item 3.1: Scope contingency represents project risks associated with an incomplete design that should become known as the design is completed. For specific remedial action technologies, a scope contingency of 10 to 20% should be used for synthetic caps. A 5% contingency was used in this estimate as this is a 90% design.

Item 3.2: Bid contingency added to account for unforeseeable costs at the time of cost estimate preparation. Bid contingency typically range from 10 to 20 percent. A bid contingency of 15% was used for No. 1 Landfarm.

Item 3.3: General contingency added to account for unforeseen site conditions that may be encountered during design implementation. A general contingency of 15% was used for No. 1 Landfarm.

Indirect Capital Costs

Item 4.1: Estimated as a percentage from KEY’s past experience on similar projects.